THE TELEGRAPHIC JOURNAL AND

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ELECTRIC LIGHTING.

THERE seems to be at last some definite likelihood that the Electric Lighting Act will be amended. The present Session of Parliament should witness the long-desired change, the change which is to free electric lighting from the chains which have hung about its neck and prevented its free progress for five or six years. The Bill now before the House of Lords, however, does not provide for the repeal of the clause which embodies what has been termed the "municipalisation" principle, but merely extends the period which must elapse ere the municipal authorities can acquire plant and undertakings by compulsion. It is true that the original period of twenty-one years is doubled, and forty-two years would seem, admitting the morality of the principle of compulsory acquisition, to be a reasonable length of time to enable the undertakers to realise some profit from their enterprise. Lord Thurlow, too, asks that goodwill should be recognised as a purchasable commodity: he has, however, signified his willingness to strike out the specific claim to compensation on this head, if it be conceded that the valuation should include that element as a matter of course. We hope he will allow this portion of his Bill to remain in the form in which it passed the House of Lords last year, so that there may be no uncertainty at the expiration of the period. However good may be the intentions of Parliament to-day, if there be no clear provision for goodwill it is pretty certain that authorities desiring to acquire electric lighting undertakings will, forty-two years hence, seek to evade the spirit and hold for the letter of the Act only. As we have said, practically the same Bill passed the House of Lords last year, and there is no reason to doubt that it will again do so; and we believe every facility will be given by the Government for its introduction in the House of Commons. Lord Onslow has suggested that no further step should be taken by Lord Thurlow until the Earl of Crawford's Bill on the same subject is brought forward. We do not see the need for a further Bill of the kind the Earl of Crawford is likely to submit; but, at the same time, there is not much need to fear opposition, for the noble earl has expressed himself strongly in favour of most, if not all, of the claims advanced by the electric lighting community.

We are not sure whether we ought to commend the City Commissioners of Sewers for their extreme caution, or to feel angry with them for giving way to the clamours of a faction. They had before them a very satisfactory proposition from a corporation of standing, which was well able to carry out the extensive work of lighting a large City area. After years of negotiation, a point was reached when agreements might have been signed and the work at once entered upon. Then appear other parties upon the scene, whose abilities and *bonâ fides* are not quite so well assured, with counter-proposals—proposals which upon the face of them bear evidence of hasty consideration, and such as we should have thought would not have secured more than a moment's attention from any member of the committee which has been in negotiation with the Brush Corporation. But there are factions in the City Councils as elsewhere, and likewise the effluxion of time brings changes of *personnel*. There appears to have been a change in the constitution of the committee, and the new men are desirous of having their say upon the electric lighting question. Naturally, they know very little about it at present, but they can learn, and the City may wait for the light whilst their education is progressing. One thing they have resolved upon, and that is that the basis of future negotiations shall be different from that upon which the proposal of the Anglo-American Brush Corporation was founded. After all, says the chairman of the committee, the Brush Company's offer in the new form may be the best. If such turns out to be the case, people will wonder what the necessity was for going all over the matter again, for surely no better terms can be expected than those already offered.

MR. HENRY HACK, M.Inst.C.E., in his presidential address at the eleventh annual meeting of the Midland Association of Gas Managers, made reference to the estimates which Sir David Salomons has published of the cost of electric lighting at his residence, Broomhill. In his remarks he allowed himself to be rather too hastily led to conclusions after obviously a not very careful examination of the facts and figures to which he took objection. He put forward as his first objection the statement that "the bulk of Sir David's calculations, being based more or less upon estimates and assumptions of (not ascertained) candle-power, cannot be accepted as conclusive." This is one of several points upon which it might be urged that Mr. Hack is mistaken. If he will look again at Sir David's *brochure*, he will find that 16-C.P. is distinctly mentioned. Proceeding in his address he says: "He has taken the extraordinary course of saddling the gas with the cost of 'candles and oil,' which he assumes would be required in addition if gas were used, even then only bringing up the cost to £2 7s. against £3 for 'the very best method of lighting by electricity.' My opinion is, judging by the usual precautions taken by 'having gas or oil in readiness' where electric lighting has been introduced, that this is a slip on the part of Sir David Salomons, and that the 2s. should really have been added to the £3, making the comparative cost £2 5s. for gas against £3 2s. for lighting by electricity." We differ from the opinion Mr. Hack has formed that Sir David has unintentionally charged the 2s. to the wrong illuminant, for we believe he really meant to imply that where gas is used, oil or candles cannot be altogether dispensed with, whilst where electric lighting obtains they can. In most large houses where gas is used, the

sitting-rooms and bedrooms are usually supplied with light by means of oil and candles; candles or lamps are necessarily in requisition after the gas is put out at night, but are not required with the electric light, the simplicity of the re-lighting arrangement being all that could possibly be required. Of course it will be urged that where breakdowns occur, lamps or candles are employed; but we believe it would be found that the number of lamps or candles used in consequence of breakdowns of the electric light is merely nominal. At Broomhill, we happen to know that there is absolutely no second string to the bow; moreover, the meaning of a breakdown is unknown there. As much cannot be said with regard to the gas supply in that neighbourhood, for it has failed upon more than one occasion within the past six months, to the danger of the inmates at Broomhill, where gas is employed for cooking purposes, several of the stoves being in locked-up rooms. The failures, we hear, were due to work done on the company's mains, and no notice of an intentional cut-off was given. There are other points in Mr. Hack's address upon which we might comment, but considerations of space compel us to refrain.

THANKS to the endeavours of the Belgian Minister in Japan, Mr. G. Neyt, who undertook to make known to the Japanese Government the invention of the well-known Belgian electrician, Van Rysselberghe, the telegraphic network of that country will soon be utilised for telephony also. All the apparatus required for an experiment has just been ordered in Belgium, according to the instructions given by Admiral Enomotto Takaki, Minister of the Empire of Japan. A fact worth mentioning to those interested in the application of electricity occurred in Japan in connection with Van Rysselberghe's invention, viz., before the Government had finally adopted the system, by desire of H. E. Inouyé Masuru, Vice-Minister of Public Works, a Mr. J. Fujioka, instructor at the Engineering College at Tokio, had reported very fully on the advantages to be derived from using the system on the telegraphic lines in Japan. From simple data extracted from the books by Mr. Buels and Mr. Ch. Mourlon on the system in question, he had succeeded in applying it to a telegraph line, using apparatus which he borrowed from the laboratory of the Engineering College at Tokio. He had a complete success, and was thus able to carry out an experiment which speaks highly for the enterprise and the technical knowledge of the Japanese. [This information reached us last week, but pressure upon our space compelled us to withhold it from publication.]

THE abstract of the paper on the heating effects of electric currents, which we publish from the proceedings of the Royal Society, is interesting. In the first point of observation taken by Mr. Preece it appears that shellac acts as a flux, and prevents oxidation, and it seems possible that fusible plugs might be better preserved by a coating of shellac varnish; the second point of observation, that of self-luminosity, would probably vary with different observers. The day will doubtless come, although it may be far distant, when a fusion of the circuit by means of an apparatus specially devised for the purpose will be numbered amongst the things of the past. Fancy a number of valves in a ramification of gas pipes, which at a given pressure should close and extinguish the lights throughout a whole district!

THIS is "Silver Wedding Week," and it is interesting to recollect that the electric light took part in the rejoicings consequent upon the marriage of the Prince of Wales with the Princess Alexandra of Denmark, on the day of that triumphal journey through the city by the Princess upon her first entry into England. She saw, or might have seen, the electric light shining forth, intermittently it is true, but still brilliantly shining from the dome of St. Paul's Cathedral, and also from the monument. But those were the early days of the most primitive forms of the arc lamp, and batteries—tremendous batteries they must have been—produced the current which caused the illumination. The Prince and Princess have undergone some varied experiences since that memorable day—and so has the electric light.

IT appears that the frequent extinctions of the electric light supplied from the Grosvenor Gallery are not due merely to accident. We are assured on credible authority, that it is the custom of the suppliers to cut off the current in certain quarters and at stated times for the purpose of giving an extra number of lights in other localities; in other words the demand is apparently greater than the supply. We can understand that customers might condone the repeated offence of extinction due to accidental causes, but we think that if they were generally aware of the method of supply and cut-off adopted by the Grosvenor Gallery authorities, an outcry would quickly be raised, and but little fault could be found with those who resented, in an unmistakeable manner, this curious method of conducting business.

IS there any truth in the rumour that Mr. F. A. Gower is alive and well, and not up in a balloon after all? It is said that matters entirely unassociated with business have caused his temporary retirement into the obscurity from which he may yet emerge.

LAST week Mr. W. J. Carruthers Wain, a well known tramway authority, boldly declared that he thought electrical traction would surpass every other system upon tram lines. Is not this a favourable time for some of our contractors, who believe in this method of propulsion, to back up Mr. Carruthers Wain by coming forward with proposals to work certain lines electrically, for a term of years at a cost a trifle below that of horses, or must we wait for Sprague, Bentley-Knight, Van Depeole or some other enterprising Americans, to come over and show us how it is to be done?

IT is difficult to understand why Lord Thurlow should have so committed himself at the meeting of the Anglo-American Brush Corporation. He surely must have been beside himself, to try to make people believe that in six years' time there will not be a gas lamp in the streets of any town in England. It is vexing enough to listen to the ravings of promoters of new electrical schemes, of enthusiastic but irresponsible lecturers, and of the daily pressmen, but it becomes doubly irritating to hear of the chairman of a well known, and firmly established company, giving vent to such extravagant twaddle as that attributed to Lord Thurlow. How the gas journals will chuckle, and with good reason, at this extraordinary outburst from a gentleman who had not hitherto, so far as we are aware, given evidence of his fitness for a private

asylum. Although we should gladly hail the advent of the electric arc for street lighting generally, we cannot blind ourselves to the fact that it can just as well be dispensed with, and Lord Thurlow ought to be, and doubtless is, perfectly aware of that fact. Such being the case, his rabid statements are all the more inexplicable.

MR. G. BERSON, in a note to the Académie des Sciences, gives the results of researches which he has made on the variations of magnetisation in steel bars, produced by blows. Experiments were made on a bar 9 millimetres in diameter and 25 centimetres long, the bar being submitted to blows from a mass of 2,400 grammes falling from various heights. In the first case the bar was placed perpendicularly to the magnetic meridian. In this case the magnetic moment of the bar became diminished by the effect of a blow towards a certain limit which was dependent upon the initial value of the magnetism, the temper of the steel, and the strength of the blow. The rate of diminution diminished gradually in proportion to the number of blows, the relative values being represented by a hyperbolic curve of the form $y = a + \frac{b}{x + c}$. Experiments were also made on an unmagnetised bar in the same position; in this case it was found that after the first blow the difference between the magnetic moments produced by the same number of blows of different strengths is sensibly the same, independently of the number. The law connecting the magnetic moment produced by a single blow with the height of the fall of the mass is given by an equation of the form $y = \frac{a\,h}{h + b}$, an equilateral hyperbola.

THE *Evening News* says that out of a total of 2,603 fires in London, no less than 671 were caused by, or connected with, the present system of lighting, which presumably would never have occurred had the electric light been used instead of gas and oil. It is possible that the fires attributed to the above cause might have been diminished if "the light of the future" had been generally adopted, but has our contemporary any idea of the number of fires of a more or less serious nature which have been occasioned by the very means it advocates for their prevention? We trow not; yet this is a matter which will very shortly necessitate enquiries of the strictest nature. Bad workmanship has been the cause of the mischief in most cases.

THE author of "Living Lights," a popular account of phosphorescent animals and vegetables, expresses the opinion that "the discovery of the secret of phosphorescence, and its practical application to the wants of mankind, would result in revolutionising present systems; a heatless, inexpensive, inextinguishable light being the perfection of possibilities in this direction." Away with unwholesome, inefficient gas, measured to us by lying meters; away with that fiction the electric light, puffed into a precarious existence by those who hope to fatten on a too confiding public! Let us go direct to nature, and let our capitalists and scientists turn their attention to the "perfection" of those "possibilities" which are held out to us in such alluring guise. But we are almost afraid that our knowledge and appliances are as yet hardly equal to the inception of such a complete revolution of existing institutions, and is it not written: "Sors tua mortalis; non est mortale quod optas. Plus etiam quam quod superis contingere fas sit, nescius affectas."

At the Convention of the American National Electric Light Association, which took place in New York towards the end of last month, it was estimated by the President, Mr. J. F. Morrison, that there were at present in the States 3,000 isolated plants of arc and incandescents, and 1,000 central stations in which were installed or contracted for 175,000 arc lamps, and 1,750,000 incandescents. This, it will be seen, is just in the proportion of 10 to 1.

"THERE is no street railway manager in America who will not throw up his hat with joy upon its being demonstrated that electricity as applied to street cars is practicable, economical, and able to do the work of horses." This was the remark of President Henry M. Watson, of the Buffalo Street Railway Company, to a representative of the Buffalo *Daily Courier*, who went to interview that gentleman on the merits of the Elieson electric locomotive, which has been sent to the States to demonstrate the applicability of the system on American tracks. The company intends giving every facility to the Elieson representatives, and even if it turns out that the cost of working is no less than that of horse haulage, the company, which owns 1,200 horses, will not hesitate to adopt the electrical system in preference, provided it proves to be safe and practicable. We hope shortly to be able to chronicle the success of the pioneer locomotive, and we feel sure that the good wishes of all our readers will be with the English company owning the Elieson system of electric traction.

WHAT do our readers think of a company which pays its shareholders a dividend of 5 per cent., yet pays in salaries no more than £94 13s. 4d.? This, the *Gas World* points out, is the amount set down in the balance-sheet of the Taunton Electric Light Company, and our contemporary thinks "the knowledge that a dividend has been declared by starving the officers takes the gloss off the glowing accounts of the success of the company which have recently been published." There are proverbially two sides to all questions, and doubtless Mr. Massingham is quite prepared to explain the reason why so small a sum is credited to salaries. The company possesses a managing director, a secretary, an auditor, an electrician in charge, and an assistant electrician.

OUR readers are probably aware that the whole of the Liverpool Exhibition buildings and structures have been placed in the hands of a firm of auctioneers of London and Manchester for public sale, since the repeated efforts made for the conversion of the buildings and grounds into permanent pleasure gardens have failed. Is this failure due to an already sufficient supply of accommodation of this nature, or is it considered that such pleasure grounds or winter gardens might fall into the ways of so many similar establishments, and exercise an evil influence on the morals of the good town of Liverpool?

ON THE DIFFERENCE OF PHASES OF CURRENTS, ON THE RETARDATION OF INDUCTION, AND ON THE DISSIPATION OF ENERGY IN TRANSFORMERS. EXPERIMENTAL AND THEORETICAL RESEARCHES.

By PROF. GALILEO FERRARIS.

(*Concluded from page* 222.)

Comparison of the Coefficients of Induction.

FROM the comparisons already made it results that experiment plainly confirms the theoretical previsions respecting the retardation, θ, and its manner of varying in different cores.

But also the values of μ, registered in the tables of experimental results, give room for instructive comparisons. The coefficient of apparent induction

$$M = \frac{T}{2\pi}\mu$$

which is found on experimenting with alternating currents is never equal to the coefficient of induction which we represented by M_1, which it would be if neither the Foucault currents nor the retardation, θ, existed. Its value is instead a function of M_1, and on those magnitudes depend the retardation of phase and the intensity of the parasitic currents.

Among these magnitudes are to be reckoned the resistance of the circuits of Foucault currents, the coefficients of induction of these currents upon the same and on the two coils of the transformer and the duration of the T period of the alternating currents employed. According to theoretical considerations the function just named will be that obtained from the equations (17).

It will be important to verify if our experiments confirm our theoretical previsions. To effect this I determined for successive cores the values of the coefficients of mutual induction between the two coils of the transformer, availing myself for this determination of a method, the results of which could not be affected by the Foucault currents.

The method employed consisted in inserting in the primary circuit of the transformer a constant battery to produce on closing or opening the circuit or on inverting the current an instantaneous induced current in the secondary circuit, and to compare the throw produced in a galvanometer with that produced in the same galvanometer on the discharge of a condenser of known capacity. On there being given, R, the resistance comprised between the two points of the primary circuit which the armatures of the condenser communicate in the act of discharge, r, the total resistance of the secondary circuit including the galvanometer, C, the capacity of the condenser, a and a', the angles of throw of the galvanometer needle produced respectively by the discharge of the condenser and by the induced current in r, M′ the coefficient of mutual induction between the two coils of the transformer, we have

$$M' = R\,r\,C\,\frac{a'}{a}.$$

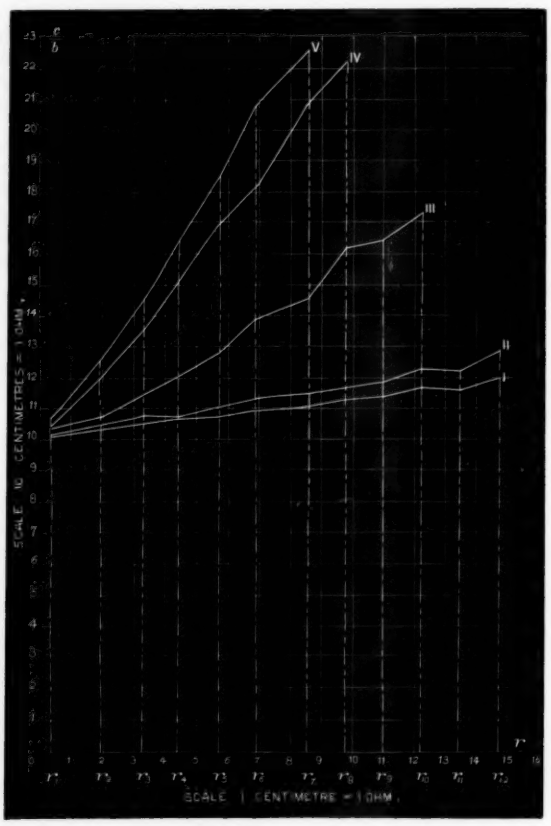
The condenser of Elliott's make was of plates of mica and had the capacity of $\frac{1}{3}$ microfarad, the battery consisted of six Daniell elements, the rheostats were from the works of Hartmann Braun; the galvanometer, of the astatic Thomson type, was from the establishment of Carpentier.

The values thus obtained are laid down in the last but one column of the subjoined table marked M′. The first column indicates the core with which the secondary nucleus was provided during the experiment. The second column contains the values of μ as previously determined. The third column gives the values of $\frac{1}{T}$, and the fourth the apparent coefficient of induction, M, as determined by the relation

$$M = \frac{T}{2\pi}\mu.$$

Core.	μ	$\frac{1}{T}$	M	M′	$\frac{M}{M'}$
1	9·09	40·28	0·0359	0·0179	2·01
2	10·10	40·13	0·0401	0·0223	1·80
3	7·58	40·13	0·0301	0·0269	1·12
4	4·90	40·13	0·0194	0·0240	0·810
5	4·54	40·20	0·0180	0·0273	0·658

The great difference observed between the values of M′ and corresponding values of M can only be the object of discussion, since in its production there concur the Foucault currents which affect M but not M′, and also the effects of remanent magnetism which are different in the two modes of experimentation. But what ought essentially to arrest our attention is the



absolutely different order according to which the values of M and of M′ vary between one core and another. The better to put in evidence this notable fact the values of the relation $\frac{M}{M'}$ have been computed and registered in the last column. This relation decreases regularly and rapidly from the value 2·01 which it has in the case of the core with thin iron wire to 0·658 which corresponds to the core formed of a single massive bar of iron. Now, although the phenomena on which depend the values of M and of M′ are very complicated, this result forms a confirmation of our previsions according to which the coefficient of induction M deduced experimentally with alternating currents should, all other conditions being equal, result so much the smaller as the Foucault currents are more intense.

It is easy to see that this observation applies not only to the values of M determined from our experiments, but to all determinations of the coefficients of induction, mutual or peculiar, based upon the use of alternating currents. Thus, for instance, the method

indicated by Joubert for determining the coefficient of induction proper to a coil by means of the quadrant electrometer when applied to a coil with an iron core gives results varying with the number of inversions of the current employed and with all the other conditions which affect the Foucault currents and the retardations of phase with which we have been concerned.

MODERN TELEGRAPH GALVANOMETERS.

WITH the exception of a few nearly obsolete forms, the galvanometers now used in telegraphy upon working circuits have needles of soft iron, in which magnetism is induced by permanent magnets. Those instruments however used for testing purposes, still have needles of steel permanently magnetised.

The galvanometers used upon working circuits are mostly differentially wound, and have vertical dials, the needle being directed to zero by gravity. The lineman's detector also has a vertical dial, but the "P.O." tangent and astatic galvanometers, which are used for accurate testing purposes, have horizontal dials, and their needles are directed to zero by the earth's field.

Two different shaped needles are used in the working galvanometers, the one being the horseshoe shaped needle introduced by Varley into the single needle instrument, and the other, introduced by Spagnoletti, is shaped similar to the needle of the Thomson's electrometer, the needle being magnetically divided in the middle and a north magnetism conducted along one of the pivots to the bottom end of the needle, and a south magnetism conducted along the other pivot to the top of the needle. The magnetic moment of these needles vary somewhat; thus with the horseshoe shaped needle I have found the magnetic moment to vary from 11 to 20 dynes, while with the canoe-paddle shaped needle the magnetic moment varied from 28 to 48 dynes in different instruments.

The intensity of the magnetism of the inducing magnets of these instruments is about 100.

A lineman's detector gave a magnetic moment of 30 dynes, while the needle of a "P.O." tangent gave a magnetic moment of 8 dynes.

To compare the relative merits of these galvanometers, a knowledge of the effective magnetic field produced by their coils is necessary. One milliampère of current produces a strength of field of about ·1 in the tangent galvanometer; and one milliampère through one coil of the differential galvanometer produces a strength of field of about ·6. Thus one coil of the differential galvanometer produces a field six times as strong as the tangent galvanometer with the same current. Now the magnetic moment of the needles of the differential galvanometers is from $\frac{3}{2}$ to six times as great as that of the tangent galvanometer, so that the action between the coil and the needle of the differential galvanometer would be from 9 to 36 times as great as that of the tangent galvanometer. And yet the tangent galvanometer produces about 12 times the deflection with the same current, so that the antagonistic force in the differential galvanometer must be from say 108 to 436 times that of the tangent galvanometer. These figures illustrate clearly the great difference between the friction of a needle suspended on a fine point and moving over a horizontal scale, and a needle pivoted at both ends and provided with a vertical scale.

The force with which the needle of the tangent galvanometer is directed to zero is H $m \sin\theta = \cdot18 \times 8 \sin\theta = 1{\cdot}44 \sin\theta$ dynes at 1 centimetre distance from the pivot, so that the force directing the needle of the differential galvanometer to zero would be 156 $\sin\theta$ dynes to 624 $\sin\theta$ dynes at 1 centimetre distance from pivot. Or ·96 $\sin\theta$ grains to 3·8 $\sin\theta$ grains at 1 inch distance from the pivot.

These differential galvanometers have their pointer so weighted that they give a deflection of 45° with 19 milliampères of current. For ordinary use it is convenient to consider they give between 2 and 3 degrees deflection per milliampère of current.

The tangent galvanometer is provided with a small directing magnet by means of which the strength of the field may be either weakened or strengthened by about $\frac{2}{5}$ its value, so that the deflection may be made from $\frac{5}{3}$ to $\frac{5}{7}$, the deflection obtained without the directing magnet.

By the aid of this magnet the strength of the field is so varied that the unit current produces a convenient deflection. This deflection is usually $35\frac{3}{4}°$, or 40 divisions, on a tangentially divided scale with 1 milliampère. And by skewing the instrument this deflection is doubled.

The old Varley differential and the modern astatic galvanometer have about the same figure of merit. They produce about 45° deflection with $\frac{1}{4}$ milliampère current; that is, they give the same deflection as the ordinary differential galvanometer with $\frac{1}{7\frac{1}{2}}$ the current.

The "P.O." astatic galvanometer gives about 1 degree deflection with $\frac{1}{2\,0\,0\,0}$ of a milliampère, while the reflecting galvanometer as sometimes used would give one division deflection with a ten-thousandth of this current.

W. MOON.

KIRCHOFF'S LAWS AND THEIR APPLICATION.

By E. C. RIMINGTON.

(*Continued from page* 226.)

Determinants and their elementary properties.

Take n^2 quantities $a_1 a_2 a_3 \ldots a_n, b_1 b_2 b_3 \ldots b_n, c_1 c_2 c_3 \ldots c_n \ldots\ldots p_1 p_2 p_3 \ldots p_n$.

Consider the product $a_1 b_2 c_3 \ldots p_n$.

Let $\Sigma \pm a_1 b_2 c_3 \ldots p_n$ represent the algebraical sum of all the quantities that can be obtained by the interchange of the suffixes in the expression $a_1 b_2 c_3 \ldots p_n$, the + sign being prefixed if the number of interchanges is even and the − sign if odd. Then $\Sigma \pm a_1 b_2 c_3 \ldots p_n$ is called the *determinant* of the above n^2 quantities, and is usually written

$$\begin{vmatrix} a_1 & b_1 & c_1 & \ldots & p_1 \\ a_2 & b_2 & c_2 & \ldots & p_2 \\ a_3 & b_3 & c_3 & \ldots & p_3 \\ . & . & . & \ldots & . \\ . & . & . & \ldots & . \\ . & . & . & \ldots & . \\ a_n & b_n & c_n & \ldots & p_n \end{vmatrix}$$

The quantities a_1, a_2, a_3, &c., b_1, b_2, b_3, &c., are known as the constituents of the determinant, and the products $a_1 b_2 c_3 \ldots p_n$, $a_2 b_1 c_3 \ldots p_n$, &c., as the elements of the determinant.

If the number of constituents is n^2, the determinant is called one of the nth order, and when evaluated is composed of $\lfloor n$ elements, half of this number having the + sign prefixed and the other half the − sign. Each element is the product of n constituents, no two of the latter which belong to the same row or to the same column occurring in the same element.

For simplicity take a determinant of the third order, this is composed of nine constituents written thus:

$$\begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix}$$

When evaluated it consists of $\lfloor 3$, *i.e.*, 3 . 2 . 1, or 6 elements. The element formed of the first constituent of the first row into the second of the second row into the third of the third row, or $a_1 b_2 c_3$ is known as the leading element, and the other elements are derived from this one by interchanging the suffixes. Thus the six elements are $a_1 b_2 c_3$ $a_1 b_3 c_2$ $a_2 b_1 c_3$ $a_2 b_3 c_1$

$a_3\,b_2\,c_1 \quad a_3\,b_1\,c_2$. To evaluate the determinant prefix a plus sign before any element if derived from the leading element by means of an even number of interchanges, and the minus sign if by an odd number. We thus obtain :

$$\begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix} = a_1\,b_2\,c_3 - a_1\,b_3\,c_2 + a_2\,b_3\,c_1 - a_2\,b_1\,c_3 + a_3\,b_1\,c_2 - a_3\,b_2\,c_1$$

Consider now a determinant of the second order

$$\begin{vmatrix} a_1 & b_1 \\ a_2 & b_2 \end{vmatrix}$$

The leading element is $a_1\,b_2$, and the value of the determinant $a_1\,b_2 - a_2\,b_1$. We may suppose this to be obtained by subtracting the product of the two constituents forming the sinister diagonal from the product of those forming the dexter diagonal.

D D is the dexter diagonal, and S S the sinister one.

The value of the third order determinant just found may be written

$$a_1\,(b_2\,c_3 - b_3\,c_2) + a_2\,(b_3\,c_1 - b_1\,c_3) + a_3\,(b_1\,c_2 - b_2\,c_1)$$

and this is the same as

$$a_1 \times \begin{vmatrix} b_2 & c_2 \\ b_3 & c_3 \end{vmatrix} + a_2 \times \begin{vmatrix} b_3 & c_3 \\ b_1 & c_1 \end{vmatrix} + a_3 \begin{vmatrix} b_1 & c_1 \\ b_2 & c_2 \end{vmatrix}$$

Thus

$$\begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix} = a_1 \begin{vmatrix} b_2 & c_2 \\ b_3 & c_3 \end{vmatrix} + a_2 \begin{vmatrix} b_3 & c_3 \\ b_1 & c_1 \end{vmatrix} + a_3 \begin{vmatrix} b_1 & c_1 \\ b_2 & c_2 \end{vmatrix}$$

That is to say, the third order determinant is the sum of three second order determinants formed from the constituents of the second and third columns, each of these determinants being respectively multiplied by one of the constituents of the first column.

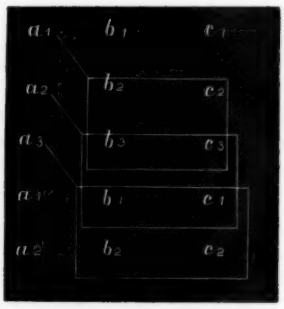
A determinant of the fourth order may in the same manner be separated into four determinants of the third order multiplied respectively by one of the constituents of the first column thus :

$$\begin{vmatrix} a_1 & b_1 & c_1 & d_1 \\ a_2 & b_2 & c_2 & d_2 \\ a_3 & b_3 & c_3 & d_3 \\ a_4 & b_4 & c_4 & d_4 \end{vmatrix} = a_1 \begin{vmatrix} b_2 & c_2 & d_2 \\ b_3 & c_3 & d_3 \\ b_4 & c_4 & d_4 \end{vmatrix} + a_2 \begin{vmatrix} b_3 & c_3 & d_3 \\ b_4 & c_4 & d_4 \\ b_1 & c_1 & d_1 \end{vmatrix} + a_3 \begin{vmatrix} b_4 & c_4 & d_4 \\ b_1 & c_1 & d_1 \\ b_2 & c_2 & d_2 \end{vmatrix} + a_4 \begin{vmatrix} b_1 & c_1 & d_1 \\ b_2 & c_2 & d_2 \\ b_3 & c_3 & d_3 \end{vmatrix}$$

Each of the third order determinants can be again separated into three second order determinants, and each of these latter consists of two terms when evaluated, so that a determinant of the fourth order when evaluated consists of $4 \times 3 \times 2 = 24$ terms, and each of these will consist of the product of four of the constituents.

Similarly a determinant of the nth order is the sum of n determinants of the $(n-1)$th order, and each of these latter is the sum of $n-1$ determinants of the $(n-2)$nd order and so on, until we reach the second order ; the number of terms in a determinant of the nth order is therefore $n\,(n-1)\,(n-2) \ldots 4 \,.\, 3 \,.\, 2 = \lfloor n$.

The following diagram will clearly show how to split up any determinant of the third order. Copy down the first two rows again at the bottom of the determinant. Then the result equals a_1, multiplied by the second order determinant diagonally beneath it, viz., $\begin{vmatrix} b_2 & c_2 \\ b_3 & c_3 \end{vmatrix}$; plus a_2, multiplied by the one diagonally beneath it, viz., $\begin{vmatrix} b_3 & c_3 \\ b_1 & c_1 \end{vmatrix}$; plus a_3, multiplied by the one diagonally beneath it, viz., $\begin{vmatrix} b_1 & c_1 \\ b_2 & c_2 \end{vmatrix}$



To evaluate a determinant by means of the process just given would be exceedingly tedious if the determinant were of an order higher than the third ; if, however, the constituents are numerical quantities, any determinant may be gradually reduced down to one of the second order by the employment of the following rules, the amount of working required being very small compared to that of evaluating the determinant in the manner given above.

Rules for simplifying determinants :—

(1.) Columns may be changed into rows and rows into columns without affecting the value of the determinant ; thus :

$$\begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix} = \begin{vmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix}$$

The leading element of each of these determinants is the same, viz. : $a_1\,b_2\,c_3$, and since the values of the determinants are obtained by interchanging the suffixes of this leading element, it is obvious that the values of the two determinants are the same.

(2.) If any two rows of a determinant are interchanged the sign of the determinant is reversed. The same applies to columns. Thus :

$$\begin{vmatrix} a_1 & c_1 & b_1 \\ a_2 & c_2 & b_2 \\ a_3 & c_3 & b_3 \end{vmatrix} = - \begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix}$$

Consider the determinant $\begin{vmatrix} b_1 & c_1 \\ b_2 & c_2 \end{vmatrix}$. Interchange the columns and we obtain $\begin{vmatrix} c_1 & b_1 \\ c_2 & b_2 \end{vmatrix} = b_2\,c_1 - b_1\,c_2$

$$= -\,(b_1\,c_2 - b_2\,c_1) = - \begin{vmatrix} b_1 & c_1 \\ b_2 & c_2 \end{vmatrix}$$

Now

$$\begin{vmatrix} a_1 & c_1 & b_1 \\ a_2 & c_2 & b_2 \\ a_3 & c_3 & b_3 \end{vmatrix} = a_1 \begin{vmatrix} c_2 & b_2 \\ c_3 & b_3 \end{vmatrix} + a_2 \begin{vmatrix} c_3 & b_3 \\ c_1 & b_1 \end{vmatrix} + a_3 \begin{vmatrix} c_1 & b_1 \\ c_2 & b_2 \end{vmatrix}$$

$$= -\,a_1 \begin{vmatrix} b_2 & c_2 \\ b_3 & c_3 \end{vmatrix} - a_2 \begin{vmatrix} b_3 & c_3 \\ b_1 & c_1 \end{vmatrix} - a_3 \begin{vmatrix} b_1 & c_1 \\ b_2 & c_2 \end{vmatrix}$$

$$= -\left\{ a_1 \begin{vmatrix} b_2 & c_2 \\ b_3 & c_3 \end{vmatrix} + a_2 \begin{vmatrix} b_3 & c_3 \\ b_1 & c_1 \end{vmatrix} + a_3 \begin{vmatrix} b_1 & c_1 \\ b_2 & c_2 \end{vmatrix} \right\}$$

$$= - \begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix}$$

(3.) If every constituent of any row or column be multiplied by a constant factor it is equivalent to multiplying the whole determinant by that factor, thus :

$$\begin{vmatrix} f\,a_1 & b_1 & c_1 \\ f\,a_2 & b_2 & c_2 \\ f\,a_3 & b_3 & c_3 \end{vmatrix} = f \times \begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix}$$

(4.) If each of the constituents of any row or column be the sum of two terms, the determinant is equal to the sum of two determinants, in one of which that row or column is formed of the first term of each of the constituents, and in the other by the second term. Thus :

$$\begin{vmatrix} \overline{a_1+d_1} & b_1 & c_1 \\ \overline{a_2+d_2} & b_2 & c_2 \\ \overline{a_3+d_3} & b_3 & c_3 \end{vmatrix} = \begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix} + \begin{vmatrix} d_1 & b_1 & c_1 \\ d_2 & b_2 & c_2 \\ d_3 & b_3 & c_3 \end{vmatrix}$$

$$\begin{vmatrix} \overline{a_1+d_1} & b_1 & c_1 \\ \overline{a_2+d_2} & b_2 & c_2 \\ \overline{a_3+d_3} & b_3 & c_3 \end{vmatrix} = (a_1+d_1)\begin{vmatrix} b_2 & c_2 \\ b_3 & c_3 \end{vmatrix} + (a_2+d_2)\begin{vmatrix} b_3 & c_3 \\ b_1 & c_1 \end{vmatrix} + (a_3+d_3)\begin{vmatrix} b_1 & c_1 \\ b_2 & c_2 \end{vmatrix}$$

$$= a_1\begin{vmatrix} b_2 & c_2 \\ b_3 & c_3 \end{vmatrix} + a_2\begin{vmatrix} b_3 & c_3 \\ b_1 & c_1 \end{vmatrix} + a_3\begin{vmatrix} b_1 & c_1 \\ b_2 & c_2 \end{vmatrix} + d_1\begin{vmatrix} b_2 & c_2 \\ b_3 & c_3 \end{vmatrix} + d_2\begin{vmatrix} b_3 & c_3 \\ b_1 & c_1 \end{vmatrix} + d_3\begin{vmatrix} b_1 & c_1 \\ b_2 & c_2 \end{vmatrix}$$

$$= \begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix} + \begin{vmatrix} d_1 & b_1 & c_1 \\ d_2 & b_2 & c_2 \\ d_3 & b_3 & c_3 \end{vmatrix}$$

(5) If in a determinant any two rows or columns are identical, the determinant equals zero : thus—

$$\begin{vmatrix} a_1 & b_1 & b_1 \\ a_2 & b_2 & b_2 \\ a_3 & b_3 & b_3 \end{vmatrix} = 0$$

$$\begin{vmatrix} a_1 & b_1 & b_1 \\ a_2 & b_2 & b_2 \\ a_3 & b_3 & b_3 \end{vmatrix} = a_1\begin{vmatrix} b_2 & b_2 \\ b_3 & b_3 \end{vmatrix} + a_2\begin{vmatrix} b_3 & b_3 \\ b_1 & b_1 \end{vmatrix} + a_3\begin{vmatrix} b_1 & b_1 \\ b_2 & b_2 \end{vmatrix}$$

$$= a_1(b_2\,b_3 - b_2\,b_3) + a_2(b_3\,b_1 - b_3\,b_1) + a_3(b_1\,b_2 - b_1\,b_2) = 0$$

(6) Any row of a determinant may be multiplied by a constant factor and added to any other row, the sum being put instead of the latter without altering the value of the determinant. The same rule applies to columns. Thus :

$$\begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix} = \begin{vmatrix} \overline{a_1+fb_1} & b_1 & c_1 \\ \overline{a_2+fb_2} & b_2 & c_2 \\ \overline{a_3+fb_3} & b_3 & c_4 \end{vmatrix}$$

By rule (4)

$$\begin{vmatrix} \overline{a_1+fb_1} & b_1 & c_1 \\ \overline{a_2+fb_2} & b_2 & c_2 \\ \overline{a_3+fb_3} & b_3 & c_3 \end{vmatrix} = \begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix} + \begin{vmatrix} fb_1 & b_1 & c_1 \\ fb_2 & b_2 & c_2 \\ fb_3 & b_3 & c_3 \end{vmatrix}$$

Now by rule (3) the latter determinant equals

$$f \times \begin{vmatrix} b_1 & b_1 & c_1 \\ b_2 & b_2 & c_2 \\ b_3 & b_3 & c_3 \end{vmatrix}$$ and this vanishes by rule (5)

(7.) If in a determinant the constituents of the first row or column are all zero except the first, the determinant reduces to the product of that constituent and the determinant of the next lower order situated diagonally beneath it ; thus—

$$\begin{vmatrix} a_1 & b_1 & c_1 \\ 0 & b_2 & c_2 \\ 0 & b_3 & c_3 \end{vmatrix} = a_1\begin{vmatrix} b_2 & c_2 \\ b_3 & c_3 \end{vmatrix}$$

We will take as an example of the foregoing rules the evaluation of a determinant of the fifth order, in which the constituents are numerical quantities. Take the determinant :

$$\begin{vmatrix} 6 & 4 & -3 & 1 & 2 \\ -7 & 2 & 8 & -1 & 4 \\ 1 & 3 & -5 & 0 & 3 \\ -2 & 4 & 7 & 9 & -1 \\ 3 & -5 & -2 & 1 & 6 \end{vmatrix}$$

Multiply the third row by -6 and add it to the first row, putting the sum instead of the latter, by rule (6). Multiply the third row by 7 and add to the second for a new second row.

Multiply the third row by 2 and add to the fourth for a new fourth row.

Multiply the third row by -3 and add to the fifth for a new fifth row.

We obtain :

$$\begin{vmatrix} 0 & -14 & 27 & 1 & -16 \\ 0 & 23 & -27 & -1 & 25 \\ 1 & 3 & -5 & 0 & 3 \\ 0 & 10 & -3 & 9 & 5 \\ 0 & -14 & 13 & 1 & -3 \end{vmatrix}$$

Interchange rows (1) and (3) by rule (2) and we obtain

$$-\begin{vmatrix} 1 & 3 & -5 & 0 & 3 \\ 0 & 23 & -27 & -1 & 25 \\ 0 & -14 & 27 & 1 & -16 \\ 0 & 10 & -3 & 9 & 5 \\ 0 & -14 & 13 & 1 & -3 \end{vmatrix}$$

which, by rule (7), equals

$$-1\begin{vmatrix} 23 & -27 & -1 & 25 \\ -14 & 27 & 1 & -16 \\ 10 & -3 & 9 & 5 \\ -14 & 13 & 1 & -3 \end{vmatrix}$$

Interchanging columns (1) and (3) this equals :

$$\begin{vmatrix} -1 & -27 & 23 & 25 \\ 1 & 27 & -14 & -16 \\ 9 & -3 & 10 & 5 \\ 1 & 13 & -14 & -3 \end{vmatrix} = \begin{vmatrix} -1 & -27 & 23 & 25 \\ 0 & 0 & 9 & 9 \\ 0 & -246 & 217 & 230 \\ 0 & -14 & 9 & 22 \end{vmatrix}$$

$$= -1\begin{vmatrix} 0 & 9 & 9 \\ -246 & 217 & 230 \\ -14 & 9 & 22 \end{vmatrix} = -1\begin{vmatrix} 0 & 9 & 0 \\ -246 & 217 & 13 \\ -14 & 9 & 13 \end{vmatrix}$$

$$= \begin{vmatrix} 9 & 0 & 0 \\ 217 & -246 & 13 \\ 9 & -14 & 13 \end{vmatrix} = 9\begin{vmatrix} -246 & 13 \\ -14 & 13 \end{vmatrix}$$

$$= 9\{-246 \times 13 - (-14) \times 13\}$$

$$= 9 \times 13 \times (14 - 246)$$

$$= -27144.$$

(To be continued.)

BERLINER'S MOLECULARIUM.

NUMEROUS devices have from time to time been constructed for the purpose of representing graphically the supposed molecular actions which give rise to the various manifestations of energy, such as heat, light, electricity, &c., but while some exemplify a theory very well in certain respects, they lack comprehensiveness and fail to explain all the phenomena observed.

In considering the means for bringing the molecular actions accompanying electrical phenomena in bodies vividly before the mind, Mr. Emile Berliner, the well-known inventor, of Washington, D.C., has, according to the *Electrical World*, constructed an apparatus which he has called a "molecularium," and by means of which the larger number of electrical phenomena can be explained on the theory of molecular vibration.

The apparatus consists of six soft rubber balls, fig. 2, which are mounted in frictional contact with each other, so that when one is rotated around an axis all the others will rotate. Each of these rubber balls represents a molecule, supposed to be itself elastic, or a non-elastic body with an elastic envelope (ether ?). The molecule is supposed to be endowed with a *permanent molecular force*, which holds it in a certain position toward all the other molecules, so that when this position is disturbed the molecule will be under stress and will endeavour to resume its original position when the cause of disturbance ceases to exist. This permanent molecular force is represented in the

molecularium by one or two spiral springs fastened around the supposed axis of rotation of the molecule and fixed to a frame in such a manner that it will resist a rotation of the molecule in either direction, fig. 1.

Furthermore, it is assumed that each molecule has an inherent electrical polarisation, which in the molecularium is expressed by colouring one-half of each of the balls a dark red and leaving the other half in their natural grey, as represented in fig. 1.

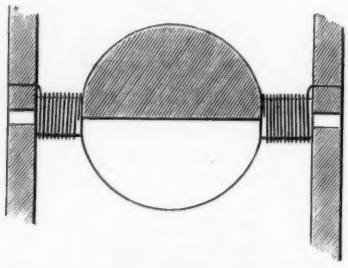


FIG. 1.—BERLINER'S MOLECULARIUM.

It may, of course, be assumed that instead of such a mounting we may represent the molecules as a series of rubber balls with bar magnets passing through their centres and floating on water. The magnet would represent their inherent electric polarisation, and the balls would assume a certain position of equilibrium which they would again assume after any disturbing influence had passed.

As, however, we are dealing for the present with solid conductors which have a certain regularity of structure, Mr. Berliner assumes, in the molecularium, the existence of a limited axis, although it appears certain that this limit has a greater range than that of a single axis (*twist, axial plane, &c.*).

For the sake of convenience a handle is attached to one of the end molecules and a check is provided for the handle to rest against, when in the normal position, representing depolarisation. This normal position is shown in fig. 2.

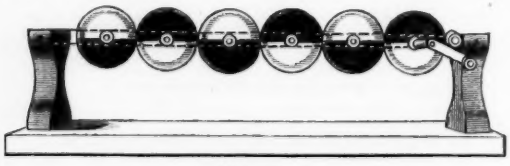


FIG. 2.

As seen here, the molecules with their inherent polarities are so arranged that these polarities oppose and neutralise each other, it being assumed that the molecular force is greater than the force of inherent polarisation; or, that inherent polarisation adapts itself, and is subservient, to molecular force. Thus, in a molecule of water the atoms consist of negative hydrogen and positive oxygen in opposition to each other and divided by the axial plane of rotation. But the question would still remain, how a liquid element, such as liquefied oxygen, would act under attempted polarisation. In solid elements their structural condition would indicate a limited series of axial rotations.

We now pass to the various demonstrations by means of the molecularium of the phenomena of electrical polarisation along a continuous conductor.

Static Charge and Discharge.

The end ball being given a quarter rotation by the crank, all the other balls will rotate within that limit around their axis and assume the positions shown in fig. 3. The molecules are now represented as being under electrical stress or polarisation, and when the crank is suddenly let go they fly back to their original position, or beyond, as will be shown later. This operation represents a *rapid discharge.*

Again the crank may be permitted to move back slowly against the partially resisting pressure of the hand which holds the crank, which operation would represent a *slow discharge.*

But polarisation is supposed to be indicated by the slightest rotary motion of the crank, and the various angles of rotation represent the *various electromotive forces* possible, while the springs represent the molecular resistance to rotation; *i.e., specific electrical resistance.* To this may be added loss of power in long conductors, *i.e.*, enfeeblement of rotation as the distance increases, which represents *difference or fall of potential.*

In a continuous current this enfeeblement will only gradually be overcome before the full influence of continuous initial rotation will make itself felt. This is equivalent to the *gradual charge* of a long conductor.

FIG. 3.

When, however, a sudden discharge takes place, the return rotation will be accelerated by the separate rebound of each molecule back to its original position, and the momentum thus given may rotate the molecules beyond their original positions before they come to a standstill. This would represent a case in which the discharge is quicker than the charge, and the action would rotate the molecules back in a greater degree or with greater electromotive force, but in opposite direction. This would represent the *extra current in a voltaic circuit.*

Voltaic Current.

A single zinc molecule, when torn off by chemical decomposition in a battery, is supposed to rotate the nearest molecule in the circuit and thereby polarise the same as in a static charge.

In a Daniell cell the degree of rotation which the zinc molecule imparts to a conductor is smaller than that produced by a Grove cell, *i.e.*, there is a *difference of electromotive force*, between the two. As one zinc molecule, however, is followed by millions of others in rapid succession, no static discharge can take place, and a struggle, as it were, ensues between the molecular forces of the conductor acting against the rotating influence of the zinc molecules; and while the *principal phase of rotation is maintained* a rotary *vibration* occurs at this phase, caused by rotation and counter rotation. This is represented in fig. 4.

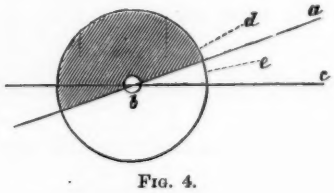


FIG. 4.

Here, *a, b, c*, is the principal phase, or E.M.F., and *d, e*, is the amplitude of vibration of the line, *a, b.*

This would apparently represent a rapidly alternating current, but the vibration is so small in proportion to the principal phase of rotation, and so rapid that its existence cannot manifest itself, except in

Heat

due to molecular vibration (friction ?). This heat may be increased either by more rapid vibration, *i.e.*, more zinc molecules, or in other words, increased *quantity* of *current*; or by a greater E.M.F.; and in both cases the resistance of the conductor when increased increases the friction and thereby produces more heat, and subsequently *light.*

As the E.M.F. increases, the rotation of the molecule is not increased in proportion, because the power of counter rotation by the molecule (tension of spring) in-

creases in an inverse ratio—*tangential function*—and may therefore become almost infinitesimal when nearing the full quarter rotation; and the heat (vibration) may become so intense as to release the molecules from their molecular attractions or molecular bearings and dissipate them—*i.e.*, *vaporisation* would take place.

This does not mean that heat can be produced only by rotary vibration, for it may be produced by rapid shocks or molecular bombardment.

As an illustration, let us assume that a hundred billiard balls are massed together on a large billiard table. A separate ball is shot by a cue against the mass, which will only be slightly loosened thereby. But, as continuous balls are rapidly shot against it, the balls eventually fly apart and against each other, and finally scatter in all directions.

REVIEWS.

Laxton's Builders' Price Book for 1888. London: Kelly & Co.

This standard book of reference for architects, builders, surveyors, engineers and contractors, not only keeps up its character for dealing carefully with the usual branches of the building trade, but in a special manner takes in hand those developments of it which of late years have received, and are now receiving, such marked attention, including sanitary engineering and electric lighting. To the latter subject six closely-printed pages are devoted introduced by the following concise statement of the present position:—"There is perhaps no subject coming within the domain of house building or domestic science that just now possesses such a wide spread and competitive interest as that of electric lighting. Whether viewed commercially, socially or scientifically, it may indeed truly be said that a world of industries already surround the subject in the many sub-divisions of distinct trades affected by it, nor do we know of any other that holds out such a wide field of promise at the present time, alike to the man of science or the enterprising trader and manufacturer. Its early days of novelty and experiment may now be said to have passed away, its pioneers have done their work, and although for some years it was a matter of conjecture whether the electric light would ever become a really practical every-day commodity, or would by degrees die out of use; yet the fact is now settled beyond a doubt, it is indeed '*un fait accompli*,' and the number of firms and specialists connected with the work is, in itself, ample evidence of the marvellous success already achieved." The book gives in detail the cost of being supplied from central stations such as those at the Grosvenor Gallery and Kensington Court, and also the outlay needed for separate installations of different kinds and under various circumstances. In comparing the cost of electric lighting with that of gas, it is stated that "many owners of cotton mills, corn mills, engineering shops, foundries, &c., who have introduced the incandescent light, can discover no material increase in their coal or labour bills, and that the sole out-of-pocket charges for the electric light are those for repairs and lamp renewals, and those do not amount to one-tenth of the charge previously made to them for gas. The Anglo-American Brush Company has fitted up numerous establishments, amongst others that of the eminent printers, Messrs. Constable, of Edinburgh, who write that they reckon that the electric light saves 30 to 40 per cent. after making proper allowance for depreciation. The Edinburgh Distillery also reckon 40 per cent. saving as compared with gas."

Maverick National Bank Manual. Boston, July, 1887. Boston, (U.S.): Wright and Potter Printing Company.

This is a volume of financial statistics which is issued annually by the Maverick National Bank of Boston. The figures are carefully compiled by specialists from the very latest sources, and the volume is both readable and valuable for reference. The various chapters treat of the history of the debts of all nations, the debts of the States and cities of America, banks, railroads, exchange, land, agriculture, coal, iron, copper, petroleum, and many other matters. An entire chapter is devoted to the subject of electrical development, giving the telegraph, telephone, electric light, and electric railway statistics of the whole world, and a chronology of the science from 1600 to 1886. The total of the telegraph lines of the world is given at 710,096. Telephone statistics are stated to be difficult of access, excepting those of the American Bell Telephone Company. With reference to lighting it appears that at the beginning of 1887 there were about 40 parent companies selling electric light apparatus in the United States, and that the capital invested in these companies and in the local companies formed to co-operate with them amounted to between $100,000,000 and $125,000,000. It is estimated that at the end of 1886 there were 150,000 arc lights installed, and that the number was increasing at the rate of from 40,000 to 50,000 a year. Of incandescents the number is estimated at 750,000. What a marked increase has taken place can be seen in our "Leaderette" columns for to-day. The New York rate for arc lights of 2,000 C.P. in 1886 was 70 cents per night, but competition brought this down in 1887 to 50 cents. For train lighting several railroad companies commenced in 1886 to use incandescent lights fed from secondary batteries, and the work is growing. The cost per lamp of 16 C.P. per hour is about one-half cent. Particulars are given of the electric railroads of the United States which carry in all about 3,000,000 passengers yearly. The length of track operated is nearly 50 miles, and there are about 75 motors and cars running. These figures, however, were expected to be materially increased by the end of 1887, and, as our readers know, this has proved to be the case. Europe is stated to have 11 electric railways, but they are not all mentioned and a slip is made in describing the unsuccessful experiment at Kew Bridge as a permanent employment of the electric motor upon the Acton tramway carrying 50 persons at the rate of 6 miles an hour. As far as we are able to judge the other statistics seem to be fairly accurate, and the compilation of the electrical chapter has been done with an amount of care deserving of commendation.

*Progress of Electrotechnics; Quarterly Reports on the most recent facts in the whole sphere of applied Electricity, including Electric Intelligence and Signalling.** Vol. I., 1887, part 3. Berlin: Springer.

This work has already in the first year of its existence become a great convenience, if we may not say a necessity, to all electricians. They may see here at a glance all that has been done in any department of applied electricity, and can, if they wish for more particular information, find references to the original treatises or memoirs.

The inventions and improvements chronicled are arranged under the heads of dynamos, electro-motors and regulators; distribution and conduction; electric lighting; electric transfer of power; promiscuous appplications of electricity; primary and secondary batteries; applications of electrolysis; chemical analysis; telegraphy; telephony; electric signalling and clocks; measurements; magnetism and induction; electrolysis; physical researches in electrical theory; terrestrial currents and atmospheric electricity.

We notice the remark that the present scientific views on the nature of electricity do not satisfy technical men. The author believes that a new conception of the nature of electricity will be elaborated in consequence of the intimate inter-contact of science and technics.

* *Fortschritte der Elektrotechnik.*

WATT'S ELECTROLYTIC ZINC PROCESS.

IN the autumn of last year we directed attention to Mr. Alexander Watt's process for producing pure zinc from impure metal, by electrolytic refining, and we are now enabled to refer to that part of his process which relates to the extraction of zinc from its ores, which has lately been submitted to a series of practical trials at the works of the Gülcher Electric Light Company at Battersea, and has, we understand, been proved to be completely successful. In these trials Mr. Watt had the advantage of Mr. W. C. Mountain's extensive electrical experience in the construction of dynamo-electrical machines for copper refining and other purposes, by which he was enabled to arrive at and obtain the current most suitable for the electro-deposition of zinc from solutions of its ores. An important feature in this process is that while the metal is deposited in a perfectly reguline form, unaccompanied by those crystalline growths of the metal termed "treeing," there is, it is said, literally no evolution of hydrogen at the cathodes, so that polarisation from this cause cannot occur, while there is also no waste of energy from this source. Samples of the zinc extracted from crude oxide by Mr. Watt's process have been submitted to us, which exhibited all the appearance of the best refined metal. It is stated that the cost of the electrolytic reduction by this process, as compared with the ordinary smelting process, shows a considerable advantage in favour of the former; and while in the process of smelting there is a loss of from 15 to 20 per cent. of metal, by the new process there is practically no appreciable loss. Another significant feature in the Watt process is that ores of low grade can be treated which could not be economically dealt with by the smelter. We are in a position to state that a company is now being formed to carry out Mr. Watt's zinc process on an extensive scale, and we wish it every success, and shall watch its progress with the interest that naturally attaches to every new application of electricity to useful purposes in the arts.

ON THE HEATING EFFECTS OF ELECTRIC CURRENTS.

ON March 19th, 1884, Mr. W. H. PREECE, F.R.S., submitted to the Royal Society a paper on the heating effects of electric currents, showing the strength of current necessary to fuse the fine platinum wire employed for protecting submarine cables from the ill effects of atmospheric electricity. The paper proved that the law that regulates the production of heat is one which can be expressed by the formula $c = a\,d^{3/2}$, "a" being a constant dependent on the metal used, and "d" the diameter of the wire. The current observed was that which heated the wire up to the point of self-luminosity (525° C.).

Since "cut-outs" of the same character as the cable lightning protector have become an essential feature of all electric lighting installations, to act as safety fuses when from accident or design an excess of current is allowed to pass through the conductor, it became most desirable to determine the current that would fuse wires of different diameters, and of different materials, so as to determine the coefficient, a, for all metals. The best material to use and the proper dimensions of the fusible wire to be employed for the protection of the electric light conductors would thus be easily deduced.

Mr. Preece obtained samples of wire of various metals (copper, aluminum, platinum, German silver, platinoid, iron, tin, tin lead alloy, and lead), and of various diameters from 0·004 inch up to 0·040 inch. It is convenient to take these measurements in thousandths of an inch (*mils*), for all our manufacturers and electric light engineers in the United States and the United Kingdom work to this gauge. The conversion of the values thus obtained into the metrical and more scientific system is very simple. The wire to be experimented upon was clamped between two small brass binding screws fixed upon a dry wooden stand.

The author pointed out in his previous paper how the cooling effects of the terminals or binding screws might vitiate the results, and how necessary it was to experiment on wires of sufficient length to prevent any error occurring from this cause. He used lengths of 6 inches to determine the constants for wires free from the cooling effect, but lengths of 1¼ inch with massive terminals to determine the constants for wires used in practice as "cut-outs."

The cooling effect of the terminals very seriously affects the efficiency of the cut-outs used in actual practice, and the larger the fusing wire and the terminals the more serious is the error introduced. On the other hand, the greater the lengths of wire used as a fuse the greater the resistance inserted, and the efficiency of the system itself may be reduced. Cut-outs, therefore, should be employed sparingly and with judgment, and the fusing wire should not be so short as to impair the fusing point.

When one considers the irregularities in drawing these fine wires to true cylinders, the difficulty in determining the current at the exact moment of fusion, and the variation in the specific resistance of the metals, Mr. Preece thinks the results must be considered very satisfactory in support of the law.

Three points of observation were taken:—

1. The melting point of a small flake of shellac placed on the wire, which may be taken at 77° C.

2. The point of self-luminosity, 525° C. This was only determined roughly in air without the dark chamber he employed previously.

3. The fusing current.

A second series of experiments was made to determine the relative effect of the sudden application of powerful currents on wires of different materials (tin, platinum silver alloy, platinum foil, aluminum foil, silver foil, pure silver wire, zinc foil, copper wire, brass wire, hard drawn bright steel wire, and mercury) such as would occur if in practice a short circuit suddenly took place. An electromotive force of 100 volts was used, and there being no appreciable resistance in the external circuit but the wire, the latter was subjected to the blow of a momentary current of immense and immeasurable strength.

The conclusions derived from these experiments were that the best metal to use for small diameters was platinum, and for large wires tin. Platinum fuses in a wax-like kind of way without explosion or scattering of molten particles. Platinum has great advantages over other materials; it neither tarnishes nor deteriorates. It is easily soldered.

Tin behaves very much in the same way when its dimensions are large. But it is very questionable whether large wires should ever be used for fusible cut-outs. Owing to radiation the surface keeps cool and solid, while the centre is molten and liquid. It bursts with an explosion, and the incandescent particles are forced away radially in all directions with considerable energy.

Fusible cut-outs are effective but somewhat barbarous, and from the absence of any scientific enquiry into their character and judgment in their use, they have in the majority of instances become rather a source of danger than of safety.

A third series of experiments was made to determine the constant "a" when each wire was 6 inches long, and therefore free from any cooling effect of the terminals.

The value of the constant "a" for the different metals is therefore:

	Inches.	Centimetres.
Copper	11684·0	2886·0
Aluminium	7948·4	1964·0
Platinum	5258·0	1299·0
German silver	5203·7	1285·0
Platinoid	4860·7	1201·0
Iron	3190·9	788·0
Tin	1800·6	445·0
Alloys (lead and tin, 2 to 1) ...	1455·5	359·5
Lead	1512·27	373·5

The values in the second column are obtained from those in the first by multiplying the latter by $\frac{1}{(2{\cdot}54)^{3/2}} = 0{\cdot}247$.

Since $c = a\,d^{3/2}$ gives the fusing current of any wire of a given diameter, d, inversely—

$$d = \left(\frac{c}{a}\right)^{2/3}$$

will give the diameter of the wire which will fuse with a given current c. Very useful tables can thus be calculated which would be of service to the electric light engineer.

[January 5th, 1888.—In all the experiments the results obtained on wires finer than those recorded, viz., those below 10 mils. were excluded, because it was found that they did not follow the law of the 3/2 power. In the discussion which followed the reading of the paper, Prof. Ayrton pointed out that this must be so, and that it followed Mr. Box's researches of 1868* that the current required to maintain a fine wire of a given material at a given definite excess of temperature is approximately directly proportional simply to the thickness of the wire. This has been fully developed in a paper read before the Society of Telegraph-Engineers and Electricians, November 24th, 1887 (*Journal*, Vol. 16, p. 539).]

THE CITY AND ELECTRIC LIGHTING.

AT the meeting on Tuesday of the Commissioners of Sewers, Mr. Bridgman brought up a report of the Streets Committee, recommending that the proposed contract with the Anglo-American Brush Electric Light Corporation, for lighting a district of the City by means of electricity, be not further proceeded with. He said this report was in consequence of the important statements and proposals submitted to the Court when the question was last discussed. The committee considered it necessary to inquire into those proposals, and before doing so they would like to clear the ground. He hoped the Court would not take this to mean that they intended to shelve the question, for such was not the case. Hitherto they had proceeded on wrong lines. The committee hoped to lay down certain conditions on which the various companies would be asked to give a price, then they would be able to judge which would be the most satisfactory proposal. The committee were anxious that no time should be lost.

Mr. C. T. HARRIS could not quite agree that the report was in consequence of proposals made at the previous Court. It was in consequence of the belief that the proposed contract with the Brush Company was wrong in principle and did not protect the rights of the City. It was never intended by Act of Parliament that the Commission should have power to grant a monopoly, but

* "A Practical Treatise on Heat," 1868.

simply a prohibitory power. The only proper way was to go to the Board of Trade and get a licence for seven years.

Mr. J. C. BELL was very sorry to see this report brought up by the Streets Committee. They had got a new Streets Committee who would take some time to master the difficulties of an electric lighting contract. There was only one company with a backbone able to carry out such a work as this.

Mr. MORTON said the committee was in favour of electric lighting, if it could be obtained on terms fair and just to the citizens.

Mr. BRIDGMAN said all they undertook to do was to make inquiry, and it might be that the Brush Company's proposal would be the best.

The report was adopted.

THE ELECTRIC LIGHTING ACT (1882) AMENDMENT BILL.

HOUSE OF LORDS, MONDAY, MARCH 5TH.

From the "Times" of March 6th.

LORD THURLOW, in moving the second reading of this Bill, said that if he could have had an assurance from the Government that they would be willing to take this matter in hand he would not have troubled their lordships on the present occasion. He desired their lordships to regard this question from the point of view of health, of science, of more light, of safety, and of the preservation of property. The object of the Bill was to remove what had proved to be prohibitive restrictions upon an industry which was deserving of every support. The restrictions imposed by the Act of 1882 had acted very harshly. The President of the Board of Trade, replying last week to a question in the House of Commons, said that since the passing of the Electric Lighting Act of 1882, 59 provisional orders and five licences had been granted to companies and 15 provisional orders and two licenses to local authorities. The President of the Board of Trade was not aware that in any single case where these powers had been obtained they had been exercised. Such was the crushing effect of the Electric Lighting Act of 1882. Still he wished to say a few words in praise of that measure, which it was the object of this Bill to amend in only one or two small but important particulars. The Act of 1882 was a most elaborate measure for dealing with a then almost unknown science. It successfully prescribed safeguards against dangers which had only since become manifest, and its object was to impose checks on rash and ill-considered schemes. It now only required trifling amendment to allow the industry to proceed, and he claimed that the time had arrived for action in that direction. In the United States there were over 120 electric light companies, paying dividends from 6 to 14 per cent., in Germany there were 604 companies, and in almost every large town in Italy electric lighting was making progress. It was only in England that the science was comparatively at a standstill, and he hoped that state of things would not be allowed to last much longer. The present time was propitious for several reasons. There never was a time when a larger amount of capital was lying idle or when there was a larger army of unemployed seeking work and finding none, and by passing this Bill lucrative work might immediately be provided for thousands of men, women, and children. He thought it would not be too much to call upon the Board of Trade to make incandescent electric lighting compulsory in all mines, factories, schools, churches, theatres, hospitals, and other places where human beings congregated together. He ventured to say that when such a demand was made the Government of the day would be neither willing nor able to resist it. Many of their lordships had no doubt visited factories lighted by gas full of toiling men, women, and children from 6.30 a.m. to 6.30 p.m., and had noticed the vitiated state of the atmosphere. The difference between that and a factory lighted by electricity was manifest in a moment. It was like being transported suddenly to another planet. Workmen who had been employed in factories lighted with electricity had told him that nothing short of starvation would induce them to work again in factories lighted by gas. It was the same in the case of mines. Electric lighting would minimize the dangers which now occurred through naked lights or faulty lamps. Then as to fires in the metropolis, Captain Shaw's report showed that the total number of fires in 1887 was 2,363, and no less than 671, or 30 per cent., were directly attributable to causes connected with existing systems of lighting. These figures did not include 691 fires, the origin of which was uncertain, and of these at least 30 per cent. might fairly be said to be due to the same cause. Then as to destruction and damage to property. Some of the first tradesmen in London had told him that they had effected great saving since they had substituted the electric light for gas in their show rooms and shops. It was also well known that the use of gas was very prejudicial to books, and the employment of electric light in libraries would be a great advantage. The Bill was precisely similar to the Bill which was passed by this House last Session, and it proposed to extend the licence granted by provisional order to any company from 21 years to 42 years. The period of 21 years fixed by the present Act was found to be too short and to be insufficient to allow electric lighting companies to recoup themselves. The Board of Trade acceded to this view, and this extension of the life of the provisional order would render the clauses with regard to the terms of purchase of less importance. He would therefore be willing to strike out of the Bill all reference to the purchase of "the goodwill" which, he understood, had hitherto been a stumbling block and a cause of opposition to the Bill. In bringing forward this measure he was solely actuated by a desire for the public interest. There existed at present a great want of employment, and yet, as was well known, there was a vast amount of capital waiting for investment. If the present Act was amended as this Bill proposed, he believed that £100,000,000 of capital would thereby find useful employment.

The DUKE of MARLBOROUGH said the Bill did not appear to contain any regulations as to the laying down of the electric cables. At present these lines were growing in number and were being run over everybody's houses without the assent or consent of householders, and he thought that it should be defined in any Bill dealing with this subject what the rights of electric companies exactly were. There had, so far as he knew, been no decision in the law courts upon the point. At present a quantity of telephone wires were to be seen running in every direction in the metropolis. The cables for electric lighting would be still more dangerous. They would in time become a great nuisance, and if the Acts dealing with electric lighting were silent on the point if would hereafter be said that Parliament had unreservedly conferred on these companies the right of running these cables over houses as at present. In New York, where electric lighting was more developed than here, the electric companies were bound to place their cables underground. If it were found impossible to make a similar provision in this country, still some regulations ought to be made as to the course they should follow, so as to prevent them crossing and recrossing public streets as at present.

The Earl of CRAWFORD and BALCARRES agreed that the Electric Lighting Act required amendment, but he thought they should deal in a thorough manner with this subject, and not merely with a single clause. In 1882, when the first Act was passed, a determination was formed that the promoters of electric lighting schemes should not enjoy a monopoly, and it was accordingly resolved that when cables were laid in the streets of any town by an electric company its work should be purchaseable by the local authority. Another provision of the Act laid down that no work should be undertaken by a company without licence from the Board of Trade or a special Act or a provisional order. These two provisions had been fatal to the measure. Licences and provisional orders had been applied for, but no work had been done. He suggested that the promoters of a scheme ought to be allowed to make their own arrangements with the local authority. Let the company pay rent for the use of the mains which they placed under the streets, and let them be absolved from the obligation of supplying light to every corner of a given district when there might be no chance of a reasonable return for their outlay. He looked forward to the day when companies would be able to lay their cables underground with a good prospect of success; but he asserted that the risks attending exposed electric mains were fewer than the risks which attended either telephone or telegraph wires. When snow fell upon an electric light main it inevitably melted, but it accumulated on other wires with the result that serious accidents were not uncommon. He hoped that the Bill before their lordships would be read a second time. Hereafter he intended to place before them a Bill of his own.

The EARL of ONSLOW said that the Bill as explained by the noble lord opposite was much less important than it was as printed. There was a clause in the Bill which covered a great deal of ground and repealed a provision of the existing Act; but he understood that when the Bill was considered in Committee the whole of that clause would be withdrawn in order that to the term of 21 years during which provisional orders must now run a further term of 21 years might be added. The Bill, as it was amended, did not appear likely to be productive of great harm, and he was prepared to assent to the second reading on the conditions the noble lord had suggested. He did not know whether the reason named was the only reason why electric lighting had not been more extensively adopted; but there could be no doubt that public expectation had been greatly disappointed in the matter. We had all hoped that electric lighting would have been much more largely used. Whether it was on account of the limitation in the number of years allowed to companies, or the fact that promoters found themselves unable to supply the electric light at prices that would compete with gas, or whether it was on account of difficulties in carrying out the supply of electricity, he did not know; but of this he was certain, that if a small alteration in the law was likely to facilitate the adoption of the electric light in London and other large towns, the Government would have no objection to it. He understood the noble earl behind to intimate that he would introduce another Bill, and if that was the noble earl's intention, it would be well that they should be in possession of both Bills before this was considered in Committee, and that both should be considered with reference to the provisions of the Bill of the Government dealing with local authorities, which would soon be produced in the other House, and which must naturally affect the powers of local authorities.

LORD HERSCHELL was not quite sure he understood what it was the Government was prepared to assent to. As far as he could gather it was that the Act of 1882 was to be amended by substituting 42 years for 21 years. If no other alteration was to be made he much doubted whether the Bill would have the effect desired. In this country we had not made the advance in electric lighting which had been made in other parts of the world. He had long desired to avail himself of this important improvement; but he had found it to be utterly impossible for the reason that

the Legislature had put impediments in the way of the spread of this invention which was not put in its way in any other country. He believed that in the South Sea Islands the electric light was more used than it was in London. This was not altogether to our credit. He quite sympathised with the desire to prevent undue interference with the control of local authorities, and it might be expedient to provide that local authorities should ultimately if they wished be allowed to become purchasers of electric lighting apparatus and to supply the electric light as they now supplied gas. He did not personally feel very strongly on that point; but he was not at all sure whether the balance of advantage was not against allowing municipal corporations to become trading bodies. With regard to the electric light, there was danger in doing this, because in some cases their conduct might be affected by the fact that they were owners of a gas business and the electric light would be a serious rival to gas. At all events, the power to acquire apparatus ought to be conferred in such a way as not to cripple the progress of invention and improvement. It was too much to ask the present generation to forego the advantages of electric lighting because their doing so might render it cheaper 30 or 40 years hence. He believed that the Indian Government might acquire Indian railways upon paying a price based upon the average value of the shares for the preceding seven years. It had been found that capitalists were prepared to risk capital on these terms, and possibly a similar arrangement might be found satisfactory to the promoters of electric lighting. He would urge the Government to consider whether on some such terms the adoption of electric lighting might be facilitated.

The MARQUIS of SALISBURY: I sympathise entirely with the remarks of the noble and learned lord, but I cannot help remembering that he was a member of the Government which passed the Act that he has denounced with so much vigour. When I sat exactly where he is sitting now, I pleaded in vain for a greater extension of the number of years, and I prophesied the results which have actually occurred. I rather think the noble and learned lord opposite is imitating those sectaries of the Middle Ages who went about laying stripes on their own shoulders for the sins they had committed. The noble and learned lord has held up to our admiration the example of the South Sea Islands in this matter; however, I am too delighted to see that the noble and learned lord recognises the difficulty in which we find ourselves to be critical as to the precise means by which his conversion was brought about. It is a matter of regret that we have not been able to make greater use of this invention, considering the vast amount of capital we have at our disposal and the great need in our smoky towns of diminishing the unconsumed carbon in our atmosphere. Although the Board of Trade has, acting under the guidance of the distinguished statesmen who presided over it during the term of office of the noble and learned lord, to some extent, I am afraid, since that time, exaggerated the danger of liberty in this matter, it is fair we should remember that we have had very severe lessons in respect of leaving uncontrolled powers to municipalities and public authorities to make binding bargains with trading companies. On the subjects of water and gas we have had very severe lessons, and we are now struggling under the difficulties that have arisen. The noble viscount near me (Viscount Cross) was said some years ago to have wrecked the Government by the proposals he made for the purchase of the undertakings of the London water companies. We now only wish that the proposals which were then denounced could be revived with success and carried into effect. We have bound ourselves by promise to the water companies which give them a hold upon us that I do not know we shall ever shake off. Undoubtedly the price at which this essential article may be furnished must have very considerably affected the progress of sanitary measures so much required in many parts of the metropolis. We have contrived to make some agreement with the gas companies. Twenty years ago we woke up to the fact that we had allowed most improvident agreements to be made with them, that we had allowed them, on the faith of competition which did not exist, to charge enormous prices. At the present moment, in regard to gas companies, we are under difficulties which could not have been foreseen by our forefathers when these terms were made, or I am convinced that the measures which they allowed to pass would have been seriously modified. The truth is that in both these cases we have made exceedingly bad bargains, and we are bound by them; and, therefore, it is not wholly unreasonable that in dealing with this new element we should approach it with some amount of caution. I quite believe we may have been too cautious, and may have run into an opposite extreme, and, by hindering the production of the electric light at the cheapest prices, may have prevented the development of this new industry. If the noble and learned lord can show us that the terms we ask can be reasonably modified no feeling of self-love will prevent us from making any alteration which your lordships may think desirable. I think we ought not to be misled by the desire to give the municipalities control over these matters. We have a sufficient number of examples as to the capacity of municipalities to carry on the business of traders on a large scale. We know the temptations are enormous, and the danger we have to face is not that the municipalities themselves will administer these trading concerns, but that they will be in the hands of paid officers wielding an enormous and irresistible power, exposed to temptations to which the municipalities themselves will not be liable, and at the same time not having the responsibility which rests upon the municipalities. I feel that the whole question of the expediency of giving this power to the municipalities has of late years been too much assumed without sufficient proof, and we should be cautious about surrendering ourselves wholly to them and preventing that protective competition of private companies which is so desirable in the interests of the community at large.

The EARL of KIMBERLEY said he remembered perfectly well that the noble marquis objected to the Bill of 1882 as being too stringent; but the latter part of the speech of the noble marquis answered the preceding part—namely, that the Government and the House in 1882 had before them evidence of the previous mistakes that had been made with regard to gas and water legislation. The Board of Trade, which was then presided over by Mr. Chamberlain, was extremely anxious that in the matter of this new invention they should not fall into their former errors. In the discussion on the Bill in 1882 he admitted that it was an experiment, and that they might possibly, by future legislation, be compelled to amend the Bill if they found that they had erred on the side of severity. It was much safer to err on that side than on the side of indulgence. With regard to the municipalities, they undoubtedly ran the risk of having too much officialism; but he would point out that there was likely to be a most severe pressure put upon the ratepayers in the carrying out of improvements, and it was a matter worthy, in his opinion, of very careful consideration whether by giving the municipalities the power to work this large invention, which provided what was, in fact, one of the necessaries of life, they should not be affording them a means of relieving themselves to a considerable extent of the burdens under which they laboured. It was because they wished to see this end accomplished that they desired to have the terms in this matter of electric lighting less stringent.

The Bill was read a second time.

LEGAL.

Townsend v. Telegraph Manufacturing Company.—This was an action, tried before Mr. Justice Stephen and a special jury, brought by Samuel Townsend, jun., of Holloway, to recover £499 10s. for alleged wrongful dismissal and breach of contract to pay for certain machinery from the Telegraph Manufacturing Company, Helsby. The case for the plaintiff was that he was engaged by the defendants in consequence of his special experience at the Tufnell Park Mills. He entered their service in November, 1886, and soon after suggested to the managing partners that he could advise them as to a machine which would turn out more work in a day than their machines would do in a week. Under agreement he was appointed superintendent of the tapeing and braiding department for the term of two years, at the salary of 30s. per week and 15 per cent. on the net profits of the department. He, on his part, promised to give full particulars of the machinery he had a knowledge of for covering with cotton silk, tape, India-rubber, &c. Delays followed in the construction of his machines by Messrs. Leeming, of Bradford, and they discharged him without notice on May 13th, 1887. The case for the defence was that the defendants had been induced to take the plaintiff into their employ by false representations as to his ability, and that he was, in fact, incompetent. A verdict was given for plaintiff for £45 and costs.

NOTES.

The Glasgow Municipal Buildings.—The minutes of the New Municipal Buildings Committee, presented to the Glasgow Town Council last week, contained a recommendation to accept an offer by Messrs. Muir, Mavor and Coulson to apply an electric current from their central station for the lighting of the buildings, the minimum charge to be £250 per annum. Preceptor Osborne moved the approval of the minutes, and Mr. Dunlop seconded. Mr. Mechan moved an amendment that the matter be taken back so that it might be fully considered. The discussion was continued at some length, and, on explanations by Mr. Osborne and others, Mr. Mechan withdrew his amendment, and the minutes were adopted.

Burnley and the Electric Light.—At the last meeting of the Burnley Local Board, the clerk submitted several letters upon the subject of public lighting; one was from a firm upon the subject of electric lighting. The Chairman said these letters had better be referred to the committee which had the question of public lighting under consideration. This course was adopted.

The Electric Light in Dover.—It is stated that an electric light company is about to put in an installation at Dover for the purpose of supplying tradesmen and others in the principal streets of the town, and that premises will be acquired near the Market Square for a central station.

Train Lighting on German Railways.—On the Würtemburg lines electric lighting has now been in use for some time, and the cost per hour for a 12½ C.P. lamp, based on the use of the light for 2,100 hours per annum, varies from ·31d. to ·44d., the average being considerably below the cost of lighting by oil gas. The advantages of electric train lighting are summarised as follow :—(1) Complete independence of the charging station, so that the electrically-lighted trains may be run over any lines. With oil gas the whole service is disorganised if through an accident at the gas works or through fire the supply of gas is interrupted ; (2) the light is better than gas, and there is no danger of explosion and fire in case of collision ; (3) the expenses for labour are lower, because no preparations are required before the light is actually wanted ; (4) the working expenses are lower, as found by experience ; (5) the cost of plant is only slightly greater than that for gas lighting ; (6) the weight of lighting plant to be carried on the train is less than with gas. Six trains on the Novara-Seregno line in Italy, and some on the Russian South-Western Railway, have been lighted by electricity by a German firm.

Lighting the Sydney Parks by Electricity.—Some time ago Alderman John Harris, now Mayor of Sydney, moved a resolution in the City Council to the effect that the Government should be communicated with for the purpose of ascertaining the probable cost and best means of lighting the public parks and squares of the metropolis by electricity. The Government was duly communicated with, and subsequently a letter was received by the Town Clerk (Mr. Daniels) from Mr. Lambert, Secretary of the General Post Office, stating that the Superintendent of Telegraphs reported, as the result of his experiments, that the best means of lighting the parks and squares of the city by electricity would be by a light and inexpensive iron trellis-work of a height to be subsequently determined, from which arc lamps to whatever number might be required should be suspended. Several electric light engineers and companies have communicated with the corporation authorities on the subject, and the whole matter will be shortly brought up before the council.

New Zealand Legislation.—A Wellington, N.Z., paper states that in the amended Municipal Corporations Act a deal of attention is given to the question of street lighting by electricity. The principal section on this point provides that "the council of every borough may do all things necessary to light the streets and public places of the borough with electricity, and to supply electricity for lighting purposes and for motive power to the inhabitants thereof, or such of them as the council may agree to supply." With regard to such electric lighting the council is entrusted with the same power as it has in respect to lighting by gas, and is at liberty to use water from waterworks for motive power. Electric lighting may be by either arc or incandescent lamps.

Gas Companies and the Electric Light.—An important decision has been recently given at St. Etienne, where the gas company attempted to restrain the town authorities from granting permission to the central electric light installation for opening out of trenches. The case was decided in favour of the electric light company, on the grounds that the monopoly originally granted to the gas company only referred to the employment of gas, all other methods of lighting being absolutely free.

Electric Lighting at the Glasgow Exhibition.—The whole of the arc lamps—420 in number—to be used in the lighting of the interior of the Exhibition have now been placed in position. The engines and dynamos for generating the electricity have still to be fitted up. In the meantime, however, a temporary engine and one dynamo have been placed in the central section of the Machinery Court, and by this means a number of lamps can now be used, if necessary, for lighting a portion of the building at night. The installation is by the Anglo-American Brush Corporation, whose system will also be used in the grounds. The engine which has been temporarily fitted up for present use is a 10 horse-power double-cylinder high-pressure Robey. There will be on view in the grounds four different systems of gas lighting, and one example of lighting with oil, besides the electric light. The picture galleries will be lighted with electricity, 40 arc lamps, fitted on the Thomson-Houston principle, being employed for this purpose. Electricity will also be used in the large dining-rooms, the system in this case being Messrs. King, Brown & Co.'s arrangement of incandescent lamps.

Coal Gas v. the Electric Light.—At the annual meeting of the South Shields Gas Company, held last week, the Chairman (Mr. R. Wallis), after remarking that there was no illuminant to compare in general utility and cost with coal gas, said its old rival, the electric light, was again beginning to assert its supremacy. A small section of the City of London was again to be lighted with the electric light, and upon the strength of that there was an attempt to "bear" the London Gas Stock, which had fallen 7 per cent. in the market since the determination to light that portion of the City. But he would advise any of those who were fortunate enough to have London Stock not to be led away by such shallow pretences. The manufacture of gas from paraffin oil was the newest and apparently the most formidable rival they had to contend with, but it got on very slowly. The cost of the oil was certainly much cheaper than coal. He, however, did not think there was much to fear from it, and altogether shareholders in gas companies, with regard to the electric light and paraffin oil, would be able to safely hold their own position.

The Electric Light in the Royal Navy.—Information from the North American station gives an interesting account of a sham torpedo attack which was engaged in by the vessels of the British Squadron. The *Bellerophon*, *Tourmaline*, *Comus*, and *Pylades* exercised their electric search lights with the view of detecting the approach of the aggressive little craft, and thus protecting the whole fleet. To test the efficiency of the electric light, an officer from the *Bellerophon* was detailed to attempt with one of the steamboats to get within torpedo distance (600 yards) of any of the ships without being observed. After several attempts, however, the enterprise was abandoned, the attacking craft being clearly visible at the distance of a mile. While the Squadron was off Charlestown quite a commotion was occasioned by the electric search light display. Unaccustomed to their plantations being lit up with such a glare, the coloured population got into a state of great excitement, and in one instance the watchmen raised an alarm of fire.

Lighting of the Grand Hotel, Paris.—This installation has been lately completely reorganised by the Edison Continental Company, 40 Jablochkoff candles have been replaced by 800 incandescent lamps, in the grand saloon, the reading rooms, the ball room, and the restaurant. These 800 lamps are fed from two Edison dynamos. About 20 Jablochkoff candles are left for the lighting of the court and entrance halls.

The Telephone in Scotland.—Barrhead is now put into direct communication with most of the centres of industry. Two new trunk lines have been built connecting Barrhead and Glasgow with a local exchange in close proximity to the railway station.

Telephone Rights in Mexico.—Mexican Courts of Justice have confirmed the validity of the Bell and Blake patents in that country. The action which led to this decision was instituted by the "Mexican Telephone Company" against a German firm which had been selling instruments proved to be exact copies of those used by the company. We understand the case will be taken before the Court of Appeal.

The Government and the Telephone.—Replying to Mr. Provand in the House of Commons on Tuesday, Mr. Raikes said that no scheme for the purchase of the telephone companies' interests was being considered by the Government, nor was there any such scheme in contemplation.

Telephone Communication in Greenock.—At the last monthly meeting of the Greenock Police Board, Councillor Bell, in moving the adoption of the Law and Finance Committee's report, drew attention to the application made by the National Telephone Company for leave to erect a line of telephone poles along certain streets in the West End, and to a memorial, largely signed, in support thereof, and also in support of erecting a fire alarm. On being put to the vote the minutes were approved by a majority of eight.

Extension of Telephony in East Kent.—Great progress is being made in East Kent with the telephone, and the prejudice it first met with is fast disappearing. The South of England Telephone Company has been to some extent itself responsible for the system not extending more rapidly, and the course it is now taking is calculated to greatly improve its business. Hitherto the only exchanges existing are those at Folkestone and Dover, and as might be expected the company, on reaching a certain point, did not make much progress. When the company established the exchanges in those towns, subscribers were led to understand that it was intended to connect up the coast in the district, and as the company did not make any movement in this direction, many of the subscribers began to show some discontent. The company is now elaborating a scheme which will not only give great satisfaction to its clients, but must very rapidly improve the business as soon as it is fairly on the road. This scheme proposes to make Canterbury a centre, from which trunk wires will be laid to Ashford, Dover, Faversham, Ramsgate, Margate, Deal, &c. If this is carried out the result will be that subscribers will have at their command not only the towns named, but several other outlying places to which the telephone is sure to be extended. It is stated that it is the intention of the company to proceed with the work at an early date. The first line that will be laid will, in all probability, be from Canterbury to Dover, the next following being from Dover to Deal, unless the company decide, as has been suggested, that the Deal wire shall run through Sandwich to Canterbury. An exchange is also likely to be opened shortly at Sandgate. Mr. Burden, the chief engineer of the South of England Telephone Company, who has hitherto been stationed at Chatham, will proceed to Canterbury to take up his residence there, in order to work the city as a central station for the proposed extension of the system.

Telephone Extension in Yorkshire.—On Monday last the National Telephone Company connected the exchange at Heckmondwike with Cleckheaton station, in response to representations which have been made from time to time by the Chamber of Commerce.

The Indian Telegraphs.—We hear that an amalgamation has just been effected between the Indo-European Government telegraph system and the Indian system proper, and that the new service will be controlled by Col. Mallock, R.E., as Director-General,

Telephoning Long Distances.—The Paris-Marseilles telephone line will be subterranean between Paris and Nogent-sur-Marne, whence it will follow the course of the Paris, Lyons, and Mediterranean Railway. The works have been almost completed in all departments through which the wire will pass. It is only necessary now to cover some short spaces, and it is estimated that everything will be in working order by July 1st. The wire, which is of bronze, is rather thicker than those of the existing long-distance lines.

Burning of Telegraph Stores.—Flames were observed to break out in the telegraph stores of the Furness Railway Company at Barrow a few days ago. The building, a large one, and built of wood, was stocked with very valuable stores, and, owing to the inflammable nature of much of the material, the flames soon had a firm hold of the building. There was a great scarcity of water, and in about an hour and a half after the outbreak the entire building was destroyed, the damage amounting to many thousands of pounds.

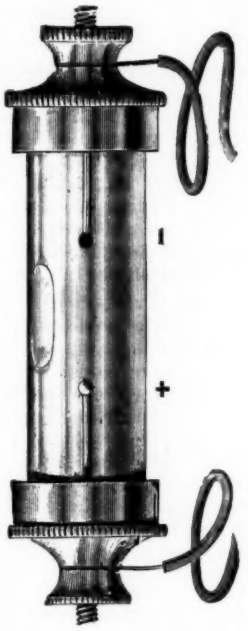
Telegraph Extension in Cornwall.—As a result of the negotiations of a committee formed for the purpose, the telegraph is to be extended from Looe to Polperro, in Cornwall. A guarantee fund has been started, and has been well supported locally.

The Channel Cables.—The Paris correspondent of the *Financial News* reports the result of a conversation with an official holding an important post at the Ministry of Finance with regard to the negotiations between the Governments of England and France for taking over the submarine telegraph lines. According to this authority the negotiations are by no means concluded, and the French Government is very reluctant to join in the matter. M. Rouvier was on the point of signing a renewed concession to the Submarine Telegraph Company for 15 years, when the English Government objected through diplomatic channels. The French Postmaster-General regretted that the matter was taken out of his hand, because he had obtained from the Submarine such advantageous conditions that his only fear was that the company would not be able to fulfil them. The Submarine Company, in its desperate efforts to obtain a renewal of the concession, promised to lay another cable to France, to open offices at Manchester and Liverpool with direct wires to France, to pay a large part of the salaries of the clerks working their wires in France, to allow telephonic communication to be established between the Paris Bourse and the London Stock Exchange, to reduce the rates, and to grant a Press rate of 1d. per word. The conclusion reached by the *Financial News* correspondent is as follows: This much is certain, it is far from being settled that the French administration will come to an agreement with the English Post Office; but whether the Submarine will obtain a renewal of the concession from France, and whether they could work the traffic under such onerous conditions as they have offered, is more doubtful still.

Society of Telegraph-Engineers and Electricians.—A meeting of the students took place on Thursday last, the 1st inst., Mr. W. M. Mordey taking the chair. Mr. W. E. Hayne opened a discussion upon Mr. Cockburn's paper on "Safety Fuses, &c.," describing several improvements, one of which is to replace the leaden pellet, an essential part of Mr. Cockburn's fuse, by a small spring; a duplex cut-out was also mentioned (devised by himself and his brother) in which a second fuse is thrown into circuit after some definite time has elapsed, useful in cases of accidental or designed short circuits, lasting only for a short time. Messrs. Lamb, Hume, Rance and Mordey continued the discussion. A vote of thanks to the chairman terminated the proceedings.

Royal Society.—Mr. F. Gotch was announced to state some "Further Observations on the Electrical Organ of *Torpedo marmorata*," at last night's meeting.

The Electrolytic Pole Indicator.—This instrument is an ingenious application of electrolysis to effect what hitherto has been done by means of a galvanometer, the advantage being that it can be used with certainty in the neighbourhood of the strongest magnetic fields. It consists of a small glass cylinder closed at both ends by metal caps bearing screw terminals. To these caps are fastened on the inside two platinum wires. The cylinder is filled with a clear liquid which, on the passage of a current, becomes decomposed, and shows a strongly defined purple tinge at the negative pole.



On the cessation of the current the decomposed matter is redissolved in the liquid, which becomes again perfectly clear. The instrument can be used an indefinite number of times without any prominent discoloration of the liquid. The indications are perfectly apparent with as low an E.M.F. as 4 volts, and it is small enough to be conveniently carried in the pocket, and is strongly made to prevent breakage; it is supplied by Messrs. Woodhouse and Rawson.

Combined Battery and Detector.—In Raworth's patent instrument, manufactured by Dorman and Smith, the cells and the galvanometer are contained in a neat polished walnut case 4 inches by 3½ inches by 5 inches high. The galvanometer is in one piece with the dial, which can be entirely removed from the case, the simple act of sliding the dial-plate into the case making all the necessary electrical connections. The cells, which are of the agglomerate Leclanché type, are sealed in ebonite cases and permanently coupled up inside the case. A hinged mirror is attached to the front of the dial, by means of which the movements of the needle can be seen when the detector is placed on the floor, or when it is hung round the neck of the operator. This when closed forms an efficient shutter to the glass window. A resistance coil of German silver wire is fixed in the case. The terminals are so arranged that the battery, galvanometer, or resistance can be used either separately or in combination as required. The instrument can be calibrated by means of a resistance box, and used as a fairly accurate resistance meter. A reference to the standard resistance contained in the instrument will at any time show if there should be any slight deterioration in the cells, which can be allowed for in the reading. The terminals are plainly labelled on the outside, and a diagram showing connections attached to inside of lid, together with a tabular scale for calibration notes. Two forms are made, one fitted with two cells for electric light work, and the other fitted with four cells for telegraph work.

The British Association.—A meeting of the local guarantors for the 1887 meeting of the British Association was held in Manchester on Tuesday. The total receipts were announced to be £4,369 10s., and after all expenses had been paid a balance of slightly over £100 remained. It was resolved to divide the surplus between Owen's College and the Literary and Philosophical Society. The recent meeting of the association was described as the most successful yet held.

Electric Communication in the House.—Mr. Hobhouse asked the First Commissioner on Monday whether he proposed to take any steps this session for establishing electric communication between the library and the House, so as to inform members occupied in the library of the progress of debate and the names of speakers. Mr. Plunket replied that the question of the establishment of electrical communication between the House and the library and other parts of the building had been considered, but there had not been up to the present time sufficient unanimity of feeling among hon. members in favour of the proposal to justify him in going on with it.

The Melbourne Centennial Exhibition, 1888.—Those firms desirous of exhibiting their manufactures at this exhibition may be interested in Messrs. Alcock & Co.'s notification on *Sup.* 5 of this issue.

The "Municipal" Lamp.—The new Edison "Municipal" lamp, as now constructed, has a platinum wire extending upwards a short distance between the two sides of the carbon horseshoe. This third wire passes down through the stem of the lamp, and is joined to fine iron wire holding a spring in tension. When the lamp breaks an arc is formed at the positive end of the carbon, and the current divides between the negative terminal and the central wire, the arc being attracted by the pointed end. The current thus diverted is sufficient to melt instantly the iron wire, thus liberating the spring under tension, which forces down a plug that short-circuits the lamp and extinguishes the arc. This novel form of cut-out is said to be perfect in its operation, avoiding all the difficulttes encountered with the older forms.

Defective Fire Alarms.—A fire occurred at the Fleece Mills, Keighley, on Saturday last, doing destruction to the amount of £40,000 and throwing a large number of people out of employment. When the fire was first discovered a policeman attempted to telephone to the fire brigade station, but the apparatus was faulty. On the alarm being received at the station it was found that the system of electric bells would not act, several of the firemen's bells not giving the required warning. This was also the case at the livery stables, the result being that no horses could be procured, the steam engines and manuals having to be dragged up by hand. Before the water could be got to play upon the burning building the fire had well nigh done its worst. It would be interesting to know whether this miserable failure of the Keighley fire alarm system is due to the contractors who have had it in hand for so many months, and who have not yet completed the entire system, or to the action of the corporation in not having its efficiency properly tested and maintained.

The "Great Eastern."—Mr. John Thomson, smith and boilermaker, West Burn Street, Greenock, has secured the contract for the breaking-up of the three large cable tanks on board the *Great Eastern*. There are 20 to 30 men employed on the work, and the compartments in which the large telegraph cables were stowed will soon be things of the past.

Magnetic "Resistance."—We have received an important article from Mr. James Swinburne on the subject of magnetic "resistance." Unfortunately it arrived too late for insertion in our current issue.

New Dynamos and Transformers.—Lord Thurlow, at the meeting of the Brush Corporation, spoke upon a topic which, although it does not appear in our abbreviated report, is nevertheless of great interest. The new dynamo and transformer which the corporation proposes to use, and which his lordship thinks will solve the question of street lighting, have both been devised by Mr. Mordey, and we are glad to chronicle the fact that his able services were most highly spoken of. This is no more than Mr. Mordey deserves, and the graceful allusion of Lord Thurlow to the benefits which the corporation had derived from his inventive powers is very gratifying.

The Melbourne Exhibition.—The forthcoming International Exhibition, to be held at Melbourne, will be lighted by means of 800 Brush arc lamps of 2,000 nominal) C.P., and about 3,000 incandescence lamps of 17 C.P., operated by 37 No. 7L. Brush dynamos and seven E_2 Victoria machines. The Anglo-American Brush Electric Light Corporation has just contracted with the Australasian Brush Electric Light, Power, and Storage Company for the supply of the whole of the dynamo machinery and arc lamps required for this extensive installation, and has undertaken to ship all the apparatus by the end of the first week in May.

Adjusting Ship Compasses.—A letter from Mr. Bottomley, in reply to Mr. E. de M. Malan, will appear in our next issue.

Telegraph Stores.—The South Indian Railway Company requires tenders for telegraph stores, to be sent to Mr. H. W. Nottage, 55, Gracechurch Street, E.C., by noon on the 13th inst.

New Catalogues.—We have received from Messrs. Gent & Co., Leicester, an advance copy of their new catalogue of over 80 pages, which appears very complete, dealing, as it does, with nearly every requirement of electrical engineering in most of its branches. It is also indexed and profusely illustrated.

Messrs. John Bell & Son, the well-known asbestos manufacturers, have sent us a copy of their engineers' stores catalogue. The book, of 200 pages, is got up in an admirable manner, and shows that the firm is in a position to execute orders for machinery, tools, and every description of engine-room sundries. Messrs. Bell & Son also propose to shortly place in the market several articles which they think will form quite a departure from the usual market commodities.

Recent Developments of Electricity.—Mr. Schuyler S. Wheeler has contributed an excellent illustrated article on "Recent Developments of Electricity as an Industrial Art" to "Harper's Weekly."

Arc Lamp Improvements.—We have inspected this week a new contrivance for striking the arc and feeding the carbons in electric lamps. The device is due to the ingenuity of Mr. Howes, of the Whetstone Park Central Station, and is simplicity itself. We have never yet seen an arc lamp so absolutely steady and so perfectly controlled, but we are not at liberty to give the details of construction.

The Swinton Intercommunication System.—"In the London ELECTRICAL REVIEW of January 27th appears an illustrated description of a Swinton patent direct intercommunication telephonic system. A system original with the Western Electric Company of Chicago, and precisely similar in all its details, was described and illustrated in the *Western Electrician*, Vol. I., No. 1, July 2nd, 1887. The system had been in use some time in their own factory and in a number of other installations."—*Western Electrician.*

Anti-Induction Cables.—Messrs. Walter T. Glover & Co. have introduced within the last two years a system of anti-induction cables for telephone working. These appear to have been very successful, and recently we have seen some specimens of the cables which have been immersed in a solution of sal-ammoniac for 12 months. The lead foil, forming part of the construction of the leads for the purpose of earthing, is apparently as good as ever, and the insulation also, which shows that the method of lead wrapping renders the cables impervious to moisture. The conductors are made in sizes varying from 10 to 100 wires, and in one special case we saw a specimen containing 240 wires.

Remarkable Coincidence.—We have had submitted to our notice the catalogue of a well-known electrical company, and that portion dealing with electric conductors of all kinds appears to have been copied literally from the list issued by another firm equally well known. We cannot congratulate the compiler of the copy, for had he exercised even the ingenuity of a schoolboy, he might have rendered the resemblance of the two lists a trifle less conspicuous. The prices also, curiously enough, are identical in every case.

Train Lighting.—On the occasion of the opening of the new line of the London and South-Western Railway to Bournemouth a new feature in railway travelling was introduced in the form of electric lighting by the use of the ordinary roof lamps and Schanschieff's primary battery. Great interest was manifested in the light, and we believe several railway directors expressed their intention of recommending its adoption. We learn that similar lamps are being made for other companies. During the trip Mr. Schanschieff also exhibited the guards' hand lamps and other of his electric appliances.

The Late Sir W. Siemens.—It is stated that a biography of the late Sir W. Siemens, by Dr. W. Pole, is in the press.

The Water Primary Battery.—A proof prospectus of Mr. D'Humy's proposed new company is before us, and doubtless we shall have something to say about it in our next. In the meantime, we may say that the pretensions set forth on behalf of a so-called invention, of which we hoped the last had been heard, are funnier and more extravagant than ever.

Death of a French Electrician.—M. Richard, the civil engineer who laid down the first network of telegraphic wires in France, died on Wednesday. When the investment of Paris became inevitable he organised the telegrapic service at Tours in the month of August, 1870. He also laid down so stealthily a wire in the Siene, connecting Havre and Paris, that not half-a-dozen persons suspected its existence. One of these was a peasant, who sold the secret to the Germans, but was afterwards punished for his traitorous act. M. Richard of late years was Government expert for all telegraphic and telephonic experiments.

The Electro-Harmonic Society.—The fourth concert of the present season, the "Amateur night" of this society, was carried out in the most pleasant manner, and it is gratifying to know that we have amongst members of the electrical fraternity and their families, ladies and gentlemen capable of sustaining the interest of an evening's entertainment in a manner which would not have done discredit to professionals. The room was charmingly arranged, and the audience appeared well pleased with the efforts of the performers, whose selections were altogether superior to the quality of music which one usually expects to meet with at an amateur concert. Mr. Spagnoletti, the chairman, in a short but felicitous speech, proposed a vote of thanks to those who had so kindly contributed to the enjoyment of the evening, and this was most cordially given.

Electricity and Simultaneous Photography.—The *British Journal of Photography* thinks that after all that has been written concerning the employment of electricity for discharging several flashing magnesium lights simultaneously, there is not the slightest necessity for doing so. Judging by what it saw at the last meeting of the North London Photographic Society, the pneumatic ball and rubber tube act quite as well as the best constructed electric appliance.

Electricteits Maatschappij.—This company, which manufactures the de Khotinsky lamps and accumulators, is now one of the largest producers of such apparatus in the world. In addition to the central works at Rotterdam, it has branches at Berlin and Gelnhausen, and is now manufacturing 2,000 lamps daily. Their incandescence lamp has not been patented, but is made by a secret process having no approach to the patents taken for other systems. Their accumulators and instruments for distribution are patented in all countries of Europe and in the United States. The company insist strongly on the necessity for accumulators as an essential part of every electric light installation.

Lightning Rods.—At the Society of Arts, a short course of lectures on "The Protection of Buildings from Lightning," by Prof. Oliver J. Lodge, F.R.S., to be delivered under the title of the Dr. Mann Lectures, as a memorial of the late Dr. Mann, will be commenced on Saturday afternoon, March 10th next. The course will consist of two lectures, the first of which will take the form of a slight historical sketch, and will call attention to the outstanding questions, difficulties, and points of controversy in connection with lightning conductors. At the second lecture, experimental answers will be given to some of the questions raised, and an endeavour will be made to supply a more complete account of the liability of conductors to side-flash than has yet been attempted. The chair will be taken at 3 o'clock.

The Van Rysselberghe Telephone System.—The Minister of Railways states that the cost of the installation of the above system between Paris and Brussels was covered during the first year of the working. A considerable extension of the system is contemplated in various European countries.

International Tables.—The issue of *Nature* for March 1st contains a communication from Mr. R. H. Scott, accompanied by a plan of international tables. Originally recommended by the International Meteorological Congress which met at Rome in 1879, the work of framing a series of international tables was entrusted to a sub-committee, whose labours have met with general acceptance among the heads of European meteorological organisations. One section is devoted to electricity and magnetism.

The Telephone in Lancashire and Cheshire.—Mr. Kenneth MacIver, the Secretary and General Manager of the Lancashire and Cheshire Telephone Exchange Company has favoured us with a copy of the latest directory of the Company's subscribers. The development of the system in this district since its introduction in August, 1879, can only be realised by attempting to master the large mass of detail embodied in the four hundred pages of this carefully compiled and well printed annual. As an illustration of the constant effort made to meet the requirements of subscribers, we notice that an arrangement has been made in connection with the Manchester Royal Exchange to accommodate the very large number of the Company's trunk wire subscribers, or their representatives, who come from the manufacturing towns to attend 'Change. An attendant is kept at the Royal Exchange Telephone boxes, whose duty it is, on receipt of a trunk wire call, to go off through the building in search of the subscriber's partner or employé who is wanted, and bring him to the telephone.

Secondary Batteries.—For some time past Messrs. Siemens and Halske, of Berlin, have been experimenting with the Epstein secondary battery. A set of accumulators is being fitted up in the Central Hotel. This is the second installation of accumulators in connection with central lighting distribution in Berlin.

The Telegraphs Deficit.—The Parliamentary return of the annual account of Post Office telegraphs, just laid on the table by Mr. W. L. Jackson, shows that the deficit for the year ending March 31st 1887, was £471,890, just £100,000 more than it was the preceding year. All this deficiency does not arise from the introduction of sixpenny telegrams, for the loss on the year ending March 31st 1885, in which year the lower rate was brought into operation, was £362,767. The total deficiency on Post Office telegraphs since the telegraphs were taken over by the Government is £3,024,899 10s. 5d.

Electric Locomotion.—Mr. Wm. Wilkinson, of Holme House Foundry, Wigan, writes to *Engineering* as follows:—In your report of a paper on 'Electricity as Applied to Engineering,' page 173 of your issue of February 17th, we observe that Mr. Volk, of Brighton, remarks that, with electrically-worked tramcars, 'grades can be used that no locomotive would face.' Perhaps Mr. Volk is not aware that the Wilkinson patent tramway locomotives are now, and have been for years, working a gradient of 1 in 11½, drawing cars containing very often from 40 to 50 passengers. From past experience we fear that any electric motor, as so far developed, would cut a sorry figure if put to the same work."

American Enterprise.—In a recent number of the New York *Electrical World* there were no less than 12 firms advertising electro-motors; 7, electric railways; and 17, steam engines for electric lighting, besides a host of others for dynamos and the more extensively used electrical plant. Where can we look in this country for any system of electric railway publicly advertised, and could not the firms supplying electro-motors be counted almost upon the fingers of one hand? We can understand the slowness with which the electric light progresses, but electrically propelled tramcars and the electrical transmission of power should have obtained a greater hold in England ere this. We should not be surprised if in the near future American enterprise invades this torpid old country to make things lively.

NEW COMPANIES REGISTERED.

Electrical Works Construction and Maintenance Company, Limited.—Capital, £2,000 in £1 shares. Objects: To carry on the business of electricians, electrical engineers, and workers and dealers in electrical motive power and light; to create, produce, store and accumulate electricity, electrical motive force or similar agency, and to apply same for production, transmission, lighting, heating, signalling, telegraphic, telephonic, electro-plating, metallurgic or other manufacturing process. Signatories (with one share each): R. E. Heywood, 101, Darenth Road, N.; S. Graham Wilmott, C.E., 42, Old Broad Street; Mozart Vinning, 33, Alexandra Road, Hornsey; C. J. Muller, 4, Hercules Passage, E.C.; F. Belcher, East Finchley; J. A. Kidd, 27, Kempsford Gardens, S.W.; G. Annesley Grindle (electrical engineer), 19, Great Winchester Street. Registered 2nd inst., without articles of association, by G. A. Grindle, 19, Great Winchester Street.

St. James's and Pall Mall Electric Light Company, Limited.—Capital, £100,000 divided into 19,980 ordinary shares of £5 each and 100 founder's shares of £1 each. Objects: To erect a central station or stations for supplying electric light and power in the district of St. James and elsewhere in the metropolis. Signatories (with one share each):—*Col. G. E. Francis, 55,

Victoria Street, S.W.; *Latimer Clark, C.E., 6, Westminster Chambers; *E. E. Molyneux Royds, Petersfield, Hants; *Peter Penn Gaskell, J.P., 12, Albert Mansions, S.W.; Capt. E. M. Palliser, 91, Earl's Court Road; Arnold Trinder, 47, Cornhill; *E. J. A. Balfour, 32, Addison Road, Kensington. The signatories denoted by an asterisk are the first directors; qualification, 100 shares of £5 each; remuneration, £1,000 per annum, or such larger sum as may be equal to 10 per cent. of the net profits, provided that £1,500 per annum be the maximum. Registered 2nd inst. by Trinders and Co., 47, Cornhill.

Chas. L. Baker and Company, Limited.—Capital: £25,000 in £5 shares. Objects: To acquire the business of Chas. L. Baker & Co., telegraph, electric surgical and scientific apparatus makers, of Worsley Street, Chester Road, Manchester. Signatories (with 1 share each): C. L. Baker, Cornbrook Telegraph Works; J. J. Bennett, Seymour Grove; S. W. Lowcock, Old Trafford (electrical engineer); T. Pelling, 2, Booth Street; F. Murgatroyd, 2, Booth Street; W. Penman, 72, Bury Old Road; J. Witham, 72, Bury Old Road; all of Manchester. The first directors are Messrs. James Leigh, J. E. Longson, Thos. Horsfield, Charles Sacré, J. H. Penman, J. Knowles Glazebrook, and C. L. Baker. Qualification: £250 in shares. Mr. C. L. Baker is appointed managing director at a salary of £500 per annum. The remuneration of the ordinary directors is to be £200 per annum. Registered 3rd inst. by Rowley & Co., 3, Great Winchester Street.

Hills and Thomson, Limited.—The registered office of this company is at Imperial Chambers, 62, Dale Street, Liverpool.

CITY NOTES, REPORTS, MEETINGS, &c.

Anglo-American Brush Electric Light Corporation, Limited.

THE seventh ordinary general meeting of this company was held at the Cannon Street Hotel on Friday last, the 2nd inst., when Lord Thurlow, chairman of the company, presided, and a fairly large number of shareholders was present.

Mr. E. Garcke, the secretary, having read the notice convening the meeting, and the directors' report (published in the REVIEW last week) having been taken as read,

The Chairman said: I shall at once address myself to the duty of the chairman to say a few words—and I will make them as short as possible, though I fear I shall have to trespass on your time perhaps a little longer than I could wish—to explain some matters that have occupied us pretty closely during the past year. I think you will concur that nearly all that has happened, if not everything, has been entirely satisfactory to your interests, and it has convinced me very fully that the affairs of this corporation rest on a sound financial and commercial basis. We have now worked at a profit during the whole of 1886 and 1887; during the last 12 months the volume of our business has increased 23 per cent. over what it was in 1886, and during the same time, owing to economies which we have been able to introduce, our net profits have increased by nearly 10 per cent. That, I think, is a very favourable statement of affairs, taken by itself; but it is still more satisfactory when it is taken and considered by the side of the great fall that has taken place in the prices of electrical appliances of all descriptions. I think you will admit that, taking all in all, those circumstances, which I repeat, of 23 per cent. increase in volume and 10 per cent increase of net profits, is not unsatisfactory. The result is to show a balance, a very respectable and substantial balance. We think that we should not be paying a due regard to the permanent interests involved if we adopted the course of paying you what I cannot help feeling myself is a small dividend. We think it is wiser to keep the money in our pockets in view of the great development which we anticipate to take place in the course of the next few months in electric lighting generally. We do therefore hope that you will concur with us that it is wiser to follow this course and to adopt the scheme which you will find in our appropriation account, of putting £2,500 to what is called provision, and carrying £2,500 forward to the accounts of this year. Before we go further I wish to say one word on the depreciation of profits, to bring home to you to what a great extent this has occurred and how greatly it has increased our difficulties. In 1881 the largest class of Brush dynamo that we made cost £800. We are now making a machine more efficient for £360, less than half, and it is only by cutting down from £800 to £360, and making a better and more efficient machine, that we are enabled at all to compete with other makers. That I think speaks for itself as regards the question of depreciation. Then as regards the economies of manufacture, by which we have fortunately, with the aid of our very efficient staff, been able to counterbalance the depreciation. I will explain in three or four words in what departments those economies have been effected. In the first place we have succeeded at length, after two or three years of attempting to do so, in bringing all our manufacturing processes and all our works under one roof, the roof of the works in Belvedere Road, Lambeth. We have been enabled to do that by subletting the works in Borough Road, and by renouncing the lease on favourable terms of our works in Portpool Lane. You may perhaps remember that for years we have been trying to do that, but the depression in trade prevented it. These last six or eight months owing, I fondly hope, to a little improvement in trade generally, we have been enabled at length to accomplish our object. We have seized the first opportunity, and we are now gathered together under one roof. That of course effects economies in every way. Then we have been able to introduce economies by making more favourable contracts for coal and oil and other things. Then a third economy that we have been able to introduce was foreshadowed in our last report. It is the arrangement that has been carried out very efficiently by the negotiations which have been conducted by our assistant secretary, Mr. Fels, with the various railway companies for the reconsideration of their rates for the transit of electrical machinery. In addition to the points that I have mentioned, in which we have been able fortunately to introduce practical and considerable economies, there is the satisfactory feature in our report as compared with the reports of previous years, that the standing charges continue to show a steady reduction—the other charges than those to which I have referred. You will find indeed that the standing charges of this year as compared with those of the year before will show a decrease of close upon £1,000. That, considering the increased volume of business, cannot, I think, be otherwise than highly satisfactory. However, I have two diagrams here that I desire just to draw your attention to, as I think they are very interesting and very satisfactory; they will convey at a glance more than a great many words of mine could. These diagrams have been prepared by our ever-active secretary, Mr. Garcke. The first shows the upward tendency of our business from 1883 to 1885, a small drop in 1886, and a rise from 1886 to 1887. This other diagram is a little more complicated, but no less satisfactory. It is a diagram showing the fluctuations in the general charges and gross profits during the years 1883–87. Comparing this diagram with the first, it will be seen that in 1884 the expenses of management fell from £21,417 to £14,700, concurrently with an increase of business, that in 1885 the expenses rose slightly, but the business and profits rose in much higher degree; in 1886 the expenses fell from £15,800 to £13,800, but, unfortunately, the volume of business also fell; in 1887 all three factors show improvement, the expenses lower than ever, the profits increased from £13,000 to £16,000, and the business increased upwards of 50 per cent. I think those are features any commercial company might point to with pride, especially at a moment like this when it is still doubtful whether there is any very active recovery of trade. Then there are several matters of great importance to your interests, but which are points of detail, to which I must request your attention for a very few moments. First as regards our Austrian business, or Continental business I might perhaps more properly call it, which is a subject I feel sure you will desire, very reasonably, to obtain some information upon. You are aware how we acquired this business. We acquired it as the result of absorbing the International Electric Company, which was really the Anglo-Austrian Company. We absorbed that company last year upon very favourable terms. We obtained possession of all their assets on terms which you approved of at the time, and which you have not since, I think, had occasion to regret. Those assets consisted broadly of two things: of the street lighting installation at Temesvar, in Hungary, and the large share that they held in the firm of Kremenezky, Mayer and Company, electrical engineers and manufacturers, in Vienna. Then, first to come to Temesvar, I will give you a few details about that street lighting. Temesvar is a long straggling town, or succession of towns. There are three towns all joined together. It is lighted now by electricity, and has been for some years. The mains are upwards of thirty miles in length in the streets of the three towns. It is lighted exclusively on the Brush system, and has been in successful operation since 1883. The contract with the Municipality is a very favourable one to the undertakers in many respects. The term of the contract is 25 years, and at the expiration of that period the Municipality can either renew the contract or purchase from us at a fair valuation. The lighting of the streets is effected by 700 incandescent lamps. When the corporation took over the installation it was not quite self-supporting, owing to the expensive manner in which some of the details were managed. Since we have had charge of it we have been able to introduce economies which have changed this feature. We have appointed a new manager, a very admirable man, Mr. Clements, and he is fully justifying the authority we gave him to deal with matters at first-hand. I am happy to be able to inform you that the private lighting along those thirty miles of streets is almost daily now on the increase, and is giving great satisfaction. Instead of being conducted at a small loss that installation is now being run at a small profit, it is true, but at a monthly increasing profit. It also affords an instance of a whole town having adopted the electric light in

preference to gas, which was formerly there. The Kremenezky-Mayer business is a business in Vienna of which the corporation acquired the larger portion when they absorbed the International Company. We have now obtained possession of the remaining portion of that business by purchase from Messrs. Kremenezky and Mayer. We paid for that a reasonable sum down in cash and made an arrangement with Mr. Kremenezky, who is a man of very great energy, to continue the management of the business. The business is an increasing one. It has before it a great field, and I believe a substantial profit. The only point I regret about it is that there are difficulties, of course, in conducting the management of a business like that at a distance, and that to do so satisfactorily it is essential from time to time, and more frequently than I like, that officers of the corporation at home should go out to Vienna and see that everything is going on properly. I greatly regret this, because it has deprived us during several weeks at a time of the services of our secretary, Mr. Garcke, whose acquaintance with Germany and the German language has been very valuable on these occasions. As regards the accounts for the past year of the Austro-Hungarian business, I regret that they were not received in time to be included in the balance sheet. They have, however, come to hand since. They have not yet been thoroughly sifted, but have been examined sufficiently to enable me to say that there is a profit on the running of that business during the twelve months. Then, gentlemen, the report alludes, among other things, to a matter of interest as being the largest piece of arc lighting that has ever been done in England—the Manchester Jubilee Exhibition last year. It consisted of 600 lamps, which were exclusively of the Brush system. It ran for six months and gave perfect satisfaction to all concerned, to the authorities, to those in charge of the Exhibition, and to the public who were served by this lighting. We undertook it, not with reluctance, because we had confidence in our ability to perform the contract, but we undertook it, at any rate, with a certain amount of risk; and the risk was that there were very heavy penalties in case of failure. I am happy to be able to inform you that at the termination of our contract we received congratulatory letters from the authorities and the exhibition people, congratulating us on the manner in which we performed the contract, and saying it did us the very highest credit; and also, notwithstanding the arduous terms on which we undertook it, the fines that were imposed for shortcomings in various details, I am happy to be able to tell you we have not been called upon to pay a single shilling. We have undertaken a similar installation at Glasgow Exhibition this year, but there will be only 400 instead of 600 lights, and I feel confident, with the experience we have already gained at Manchester, and with the experienced hands we can now put to it, that we shall be able to give at least equal satisfaction at Glasgow to that which we have given at Manchester. I now come to a subject of great importance: it is known as compound-winding, for which we hold exclusive patents. There was some litigation, as you know, going on last year upon this subject. We had every confidence in the strength of our position, and I am happy to say that that position has been recognised by all the leading makers in Great Britain. It is especially satisfactory to us that the great firms, like Messrs. Crompton and many others, whilst they felt it their duty at first to oppose our claims, have behaved honourably in this matter, and they have at once taken licenses, agreed to pay royalties, paid back royalties, and in place of any soreness now existing between us and them on account of that threatened litigation with them, I am happy to say that this has brought us nearer together than ever, and with those firms we are now acting perfectly harmoniously and with unanimity. We consider that we have now established our position in regard to compound-winding machines, and that no machine in Great Britain can henceforth be made on this principle without our consent and payment to us. There is only one firm which now contests our rights. We do not regard their action as of any importance. Then compound-winding is not the only subject of technical importance to which the attention of our staff has been directed during the past year. Electrical science, as you know, has not yet reached perfection or maturity. It is necessary to follow progress made in the laboratory very closely to keep in the fore rank of manufacture in this class of goods. It is for this reason that you will find in our accounts every year a sum, and this year it is a small sum, a few hundred pounds, devoted to what we call development of various patents and further improvements and inventions, without which we should infallibly fall into the background, and lose the leading position which we now occupy. We are now making alternate current machines under entirely new designs and patents. And we have also patented, and are adopting, a new type of transformer for transforming high-tension into low-tension currents, and *vice versa*. The only other matter in connection with what I almost call matters of detail to which I desire to call your attention is a scheme which we have introduced into our establishments, called the bonus scheme, to which I have already alluded, for admitting the principal officers of our staff and the heads of departments to participation in the profits. We do not adopt a scheme of that kind, of course, without mature consideration. It is nothing new. You know it has been adopted by very many of the largest firms in the kingdom, and successfully adopted. I understand that it has been adopted by the Bass Company, the great brewers, by the Tangye Company, the engineers, and by Cassell, Petter and Company, the publishers. We feel sure that it is a right principle, and we have after mature consideration adopted it, subject to your approval. As it nominally professes to deal with a portion of the profits, it cannot be undertaken without the sanction of the shareholders. But I think you will agree with me that the deduction from your profits that it will entail is more nominal than real, for we have proved to our satisfaction, and we believe that the accounts this year already show it, that it does not amount really to a deduction from profits, but to a small percentage of the economies effected, which goes into the pockets of those who alone can effect these economies. I hope, therefore, that if you approve of this report and balance sheet you will also bear in mind that you are approving this principle. There is one point about which I desire to say a few words. But perhaps before I come to it I ought to refer to some of the figures which are very striking in the balance sheet. You will find that the first figure on the creditor side of the balance-sheet is the figure at which our patents now stand. You will see that our patents now stand at £57,674 16s. 6d. Well, I am bound to say that, knowing what those patents cover, I consider that that figure is an eminently satisfactory one. It is a figure that I can regard with the most perfect equanimity; and that has been in the past written down to the very lowest figures at which those properties can possibly stand in your balance-sheet. You must remember that in 1882 your patents stood at £179,466. Since 1882 they have been written down at different times to the figures at which they now stand. And not only that, but you must take into consideration that we have re-acquired the Brush licenses for the metropolis, for the provinces, the Continent, and British India, with the exception of Hyderabad and Bombay. In addition to that we have acquired new patents, to some of which I have referred, whilst to others I have not. Our patents are stronger than in 1882, are more valuable, and stand at between a third and a fourth of that price. That is not a point that I have any desire to shirk any examination into or any question upon. Then the next figure is property; that stands at £82,737 13s. 2d. That is a figure which also will bear any amount of examination. You must recollect that it represents freehold properties of increasing values; it represents leasehold properties of which the same may be said; it represents a variety of property of different degrees in London, in the provinces, and on the Continent of Europe, which I feel sure, if it were realised, not suddenly, but with common prudence, would give you a very good return for that figure at which it now stands. And in considering that figure you must be kind enough to remember that there is a provision made for any shortcomings in this or any other of the items on the other side of the account, which, if you adopt this balance-sheet, will be increased to £16,500. Therefore, I consider that that figure will bear any amount of crucial investigation. Then take for one moment the question of our debtors and creditors. Last year we owed our tradesmen on current accounts for goods supplied in the course of our business to enable us to manufacture, £12,848; this year, notwithstanding that we are doing more work, that our shops are much more busy, and that our contracts are much heavier, I am thankful to say that we have kept pace with our standing account, so that we owe our tradesmen £500 less than last year. Then the money due to us from debtors is bigger. They owed us last year £30,601; this year you will see there is an increase of 50 per cent. to £45,604, and I maintain that for so large a sum it is as good as such a figure can be in accounts of this description, and eminently satisfactory to us. Then there is a point which I had hoped General Webber might have been here to have spoken to you about—that is, the City lighting. The City lighting negotiations, which we have been conducting with the Commissioners of Sewers, have now been proceeding for several years. We have been going on patiently, and have met the Commissioners of Sewers with every attention. Those negotiations are not, I am sorry to say, sufficiently completed to enable me to tell you that they are final; but at the same time I have every conviction in my own mind that after the length of time they have been going on, and from the close points to which we have got now in them, there can be but one result to them, and that is, the acceptance of our offer. Our offer, as it at present stands before the Commissioners, is not by any means a favourable one to the Corporation. By it we have to deposit £1,000, which we are to forfeit entirely if we fail to begin work within a certain time, a very few months, after the signing of the contract. Sufficient guarantees would also be placed in the hands of the Commissioners of Sewers to completely cover any risk that may be run from any undue temporary monopoly that we might acquire under the contract with them for private lighting. In fact the Commissioners of Sewers, very properly—I give them the greatest possible credit for their caution—have seen fit to surround the contract which is to be given to us or to somebody else with every conceivable protection in the interests of the public. If we get that contract we shall, I need not tell you, do our utmost, and I feel confident we shall be able to execute it satisfactorily. But it will not be a contract from which directly we shall obtain enormous profits or anything more than a fair and reasonable tradesman's profits; but indirectly, of course, it would benefit us. It would give a spurt to electric lighting all over the kingdom, and in every town in Great Britain. And in this connection it may be satisfactory to you that I should mention that we have in the last few days received letters addressed to us spontaneously by some of the largest electrical firms in Great Britain, expressing to us their sympathy with us in the wearying delays in these negotiations, and hoping that these delays may not be much longer protracted, as they are so detrimental to electric lighting interests generally. That is all I have to say in the absence of General Webber on this point. We now come to the subject of the proposed acquisition of a portion of our works by the South

Eastern Railway Company. You know this matter has been long pending. Like the City lighting, it is a thing which must come in time. The South Eastern traffic is increasing: they have doubled the line partly, they have doubled the bridge, and they have made a hole in the wall connecting with us. They want to acquire our property, but they cannot do so without paying a suitable figure for the inconvenience they would cause us if they forced us to leave Belvedere Road altogether. It is a very convenient situation; we have been improving our appliances, and we have at last, as I told you just now, finally got everything under one roof; and we are still threatened by the usual Bill laid before Parliament to take portion of our works. We do not want to prohibit them—we are not dogs in the manger. Let them take a portion; but we are determined that they shall take neither a part nor the whole without compensating us. In the meantime, I may say that the negotiations are being carried on in the most friendly and neighbourly spirit, and I have every confidence that they will come to a speedy and favourable termination. We are not too exacting in our demands, and I think we shall bring the railway authorities very shortly to recognise the justice of the reasonable compensation that we seek for the taking away of this portion of our property. I now come to a point which I had not intended to say a single word about, that is the threatened litigation, or more than threatened litigation, the litigation which is in progress with the Edison-Swan Company. I had not intended to say a single word on this subject. I am one of those who accept the doctrine that there is an unwritten law and a very proper custom, not to discuss in public matters of this kind that are actually before the Courts. I do not think that it is very right to do so; it is an abstention that is usually practised in the Press, and I think at meetings of this kind, to which all the publicity of the Press attaches, it is in a general way wise to follow this practice of silence. As, however, that view of the case was not taken the other day by Mr. Forbes when he addressed his shareholders at the Swan meeting, I hope you will pardon me if I also ask your permission to say a very few words. Now, I have not a word to say against what fell from the lips of Mr. Forbes as regards ourselves. He spoke courteously, I am told, of this Corporation, and specially went out of his way to say that the term of rascally infringers, of which he made use, was not intended to apply to us, and that he recognised that we possessed certain patents. That is very good of him; and I think there is nobody knows better than he that we do possess certain patents, and I desire myself to assure you that if this matter does go into the Courts—has gone into the Courts, and is to be decided by the Courts, it is owing to no fault of ours, and that we have approached Mr. Forbes's company at different times, and made every proposal to him that we felt we could properly make, honourably make, as the custodians of your honour and of your patent rights. If an arrangement has not been come to, I cannot admit for a moment that it is owing to any neglect on our part of what we might reasonably have been expected to do in this matter. The matter will now most probably go to the final arbitrament of the Courts of law. We are advised by our counsel, and by some of the greatest experts and most powerful technical minds in the country, that we have not only a good cause, but an overwhelmingly strong case. We are armed at all points, and are ready for the fray. We have no hesitation in going into Court; we have faced the position which has been forced upon us not only with equanimity, but with perfect satisfaction and confidence, and will abide by the result. We are not blind to the uncertainties of law, nor of the uncertainties of lawsuits, but we feel sure that if ever any company or corporation went into a lawsuit with a good case and a good conscience it is ourselves on this occasion. Then there is this feature also about it which I would ask you to consider. We feel that the maintenance of patent rights governing this matter of electric lighting for some years to come is of the greatest possible importance to the public, as the main, if not the only, hindrance to cheap and dangerous systems which the public are not yet sufficiently well educated to be on their guard against, and which bring electric lighting into disrepute. Whatever may be the result of this suit, it can hardly fail, if threshed out in the courts of law, to weaken, if not break down, those barriers of patents to which I refer as the only protection which the public can have for years to come from scrupulous and ignorant promoters to whose wiles the present free trade in electric lighting must expose householders. And you must remember that these actions, whatever the result to us, only affect one portion of our business; while to the Edison and Swan Company defeat probably means ruin and destruction. Well, gentlemen, that is all I have to say upon that point, and I am thankful to say it is all I have to say on every point. But I desire to take this opportunity, before I sit down, to thank a well-known gentleman in the City—perhaps the best known gentleman in the City—the able and indefatigable Secretary of the Stock Exchange, Mr. Burdett, for sending to me, as he courteously did, a copy of his invaluable work, "Official Intelligence for 1888," and to draw your attention to one of the introductory chapters in that volume on the early history of gas lighting. It is satisfactory reading for all those who are interested in electric lighting. You will find, I think, at page 33 of that book detailed the difficulties that gas lighting met with at its introduction in the early years of the century, in 1801 and 1802. You will find the hopeless struggles that the introducers of the gas industry met with for 15 or 20 years. How hopeless it seemed at that time can only be gathered from reading those few pages. Even in the absence of legislative restrictions, to which we are exposed, but I hope will not long continue to be exposed, the introducers of gas at that time found that it took 25 years before they could work gas at a profit, and even then it was only by the original shareholders sinking two or three times and absolutely using every farthing invested in that industry. You know how much money has been lost in electric lighting. I can assure you that by studying those two or three pages you will arrive at the conclusion that not a tithe has been thrown away in electric lighting of what was lost and thrown away in gas. And, so far from taking 25 years to introduce electric lighting, I don't like to prophecy, but I venture to say that in less than half that time—that, is, in 12 years from the introduction of electric lighting in 1880—there will not be a gas-lighted town in the kingdom. I have placed our position before you as nakedly and perfectly as possible. I have concealed nothing, and will endeavour to give you details on any points upon which you may ask for information. I desire to thank you for the extreme attention with which you have received my imperfect remarks, and venture to move the adoption of the report and balance-sheet for the past year.

Mr. Sellon: I beg to second the resolution put before you. I am sure you will all agree with me that no amplification is needed on my part with regard to the matters which have been dealt with by our chairman in his usual comprehensive and very explicit manner. I have so often had the honour of addressing you on these occasions, that my views as to the prospects and progress of the electric lighting industry in general, and your interests in particular, are known to most of you. The development and perfecting of this most important of industries is now accomplished, and the superiority of the electric light, under every conceivable condition, has been proved in the face of almost insuperable difficulties, and there is now no going back. How rapid its progress may be now that the British public have realised its advantages may be gathered from what was done last year. We are slower than our American cousins in making a start, but once fairly started we can go ahead as they do. To-day in the United States there is not a town, scarcely a village, without its complete electric light station, and one company alone has in operation upwards of 100,000 lights and 1,000 electrical plants. This one company has stations in New York, Philadelphia, Boston, and Chicago, of a capacity of 150,000, 50,000, 40,000, and 50,000 lamps respectively. Is there not in this state of things great encouragement to even the most faint-hearted amongst us? The time cannot be far distant before we shall have an equal development on this side. I have pleasure in seconding the resolution.

Mr. Hart asked whether any steps had been taken in view of the contemplated acquisition of their Belvedere Road premises by the South Eastern Railway Company, towards securing other works, in order that the operations of the corporation might suffer no interruption. The chairman of the Swan Company had stated that this corporation stood in the same position in regard to the incandescent lamp litigation as did Messrs. Woodhouse & Rawson; he (Mr. Hart) would like to know how far that statement was correct. The shareholder also alluded to the recent changes on the board, remarking that whilst the number of directors was now two less than last year, the total of their fees remained at the same figure.

A Shareholder inquired the relative cost of electricity as compared with gas, his question, he stated, being prompted by a recent statement by a director of a gas company, who asserted that, although electricians said that the price of electricity as compared with gas at 2s. 9d. per thousand feet was 6s., it was in reality 10s.

Mr. Weir congratulated the directors upon the generally satisfactory nature of their report, but expressed his opinion that the amount of stock in hand and in process of manufacture, valued at £64,448 7s. 5d., was slightly excessive. He approved of the plan which the board proposed to adopt, of giving a bonus to the heads of departments; he had tried the plan in large works, and found it a great success.

Another Shareholder, remarking upon the fact that nearly all the directors were scientific gentlemen, suggested that they should add to their number one or two practical men connected with manufacturing firms.

The Chairman, replying to the questions put, said: Mr. Hart wanted to be assured, and very properly, that we were not neglecting the important question of what we should do if we were turned out of our present premises. I think I said just now that the matter was receiving our careful consideration and attention. We cannot, of course, commit ourselves to taking new works until we are turned out of the old ones, and it is quite uncertain whether the railway company will take only a portion at first or what the exact size of that portion will be, and until the matter is a little more accurately ascertained it is impossible for us to commit ourselves by taking new works. I can assure you that the matter is under the serious consideration of the board, and that we are quite alive to the necessity of not having our manufactory interfered with by anything that the railway company may do in the way of taking away portion of our property. I do not think there is any need for anxiety under that head; on the contrary, I think the matter is one which may fairly be left to the directors. When we do come to any decision we shall have to bear the responsibility of that decision. As regards litigation, it is not, of course, right to discuss merits, but I will ask Mr. Renshaw, our solicitor, to say a few words presently, following the example of Mr. Forbes the other day, who invited Mr. Crisp, the Edison-Swan Company's solicitor, to address the shareholders of his company.

A Shareholder stated that a recent article in the *Standard*

described the lighting of a factory, he believed at Bolton, where there was a saving of 29 per cent. in favour of electricity.

Mr. Renshaw said with regard to the litigation, he quite agreed that it was not very advisable to discuss the merits of the question at this moment; but he might point out the exact position in which the matter stood. In the first place he would say that the Brush Corporation did not seek the litigation: it was forced upon them by the Edison Company. But when it was forced upon them they looked into their patents and discovered that every Edison lamp infringed one of the Brush Company's patents. There was also an infringment in connection with storage batteries of a patent of Lane-Fox owned by this company. They were able not only to defend themselves against the suit of the Edison-Swan Company, but also to commence a cross-action against Edison-Swan, and they were assured by their counsel and by scientific experts that they would succeed. With regard to the action of the Edison-Swan Company against the Brush Corporation upon the incandescent lamp, it was practically re-trying the case of Woodhouse and Rawson, but re-trying it with new evidence, and such new evidence that they felt sure of success upon Edison's patent, and upon Cheesbrough's patent also. With regard to Edison's patent, they were perfectly sure that they could overthrow it; at least they were assured so by the most competent men whom they had consulted in the matter.

The Chairman then put the resolution for the adoption of the report and accounts, and it was carried unanimously.

The retiring directors, Messrs. J. S. Sellon and J. B. Braithwaite, and the auditors, Messrs. Cooper Bros., were re-elected.

The Chairman, replying to a vote of thanks proposed by Mr. Weir, alluded to the introduction of his Electric Lighting Act Amendment Bill in the House of Lords, and said he had received assurances of the support of the Government. It was to be read a second time, if there was no opposition, on the following Tuesday, and would be proceeded with in the House of Commons at the earliest moment. Last year there were certain difficulties with the House of Commons, but he thought that with improved procedure and arrangements for the transaction of business, the same dangers would not be found this year, and there was every reasonable prospect that the Bill would come on for consideration.

The meeting then terminated.

The Telephone Company of Egypt, Limited.

THE fifth ordinary general annual meeting was held at the company's offices, 14, Austin Friars, on Tuesday, when the chairman, General Alex. Fraser, C.B., R.E., presided.

Mr. Alex. B. Chalmers, the secretary, having read the notice convening the meeting, the following report of the directors for the year ending December 31st, 1887, was taken as read:—The amount of revenue accrued for the past year exceeds that of the previous year by £498 18s. 10d., the working expenses have, however, been heavier, due to a large extent to reconstruction of some of the lines, the cost of which has been charged against revenue. After writing off a sum of £219 9s. 5d. for depreciation, the net profit for the year is £3,844 0s. 4d., and including £442 8s. 2d. brought forward from the previous year, there is avaiable for distribution £4,286 8s. 6d. Out of this the directors propose to pay a dividend of 6 per cent. for the year on the preferred shares, which will absorb £3,621 6s., and to carry forward £665 2s. 6d. The dividend now proposed will be applied in payment of the arrears of cumulated interest to December 31st, 1885, which will thus be finally discharged, and dividends hereafter declared will belong to the years for which the accounts are rendered. The past year has been marked by the opening of two small exchanges at Zagazig and Mansourah, and the directors believe that there is room for still further development in this direction. Permission has lately been granted by the Government for an extension of the system to Hélouan, and a trunk wire connecting Cairo with that place—distant some 16 miles—is now in course of erection. A royalty will be payable to the Government on the gross revenue of this branch in consideration of the permission accorded. The directors deeply regret to have to record the death after a very short illness of Mr. A. D. Evans, the company's late manager in Egypt, which took place at Brighton on October 15th last. The success which has characterised the operations of the company in Egypt, has been largely due to the assiduity with which Mr. Evans conducted the business. The following figures show the progress made by the company since its formation:—

	On December 31st				
	1883.	1884.	1885.	1886.	1887.
Total number of Subscribers in Egypt	454	547	714	817	917
Gross Revenue ...	£6,400	£7,014	£8,650	£9,400	£10,000

In order to liquidate the loan from the Oriental Telephone Company, Limited, and to provide for working capital, the directors propose to create 6 per cent. debentures to the extent of £20,000, and to issue £10,000 thereof.

The Chairman, in moving the adoption of this report, said they might look upon the position of the company as being very favourable. Starting in 1883, they paid for the first year 2½ per cent. on the preference shares, in 1884 3 per cent., in 1885 5 per cent., in 1886 6 per cent., and for the last year they proposed to pay a similar dividend. After writing off a considerable sum for depreciation, they carried forward an amount which would practically be equal to 1 per cent. on the preference share capital. The gross business had increased by quite 50 per cent. since they started, but working expenses had not increased in anything like the same proportion. For this happy feature of economical working in their business, they were greatly indebted to the late manager, Mr. A. D. Evans, whose death was regretfully alluded to in the report. As a tribute to the memory of the late officer they had appointed his son, Mr. W. N. Evans, manager in his place; but they had not done so without assuring themselves of his fitness for the position. At the same time they had accepted the offer of three gentlemen of known position in Egypt to form themselves into a general committee, to discuss matters of importance with the manager. The committee had been formed, and they anticipated successful management from this arrangement. So far the new manager gave evidence of the possession of qualities of caution and economical management which were so distinctly shown by his father. Since the printing of the report the extension of the business to Helonan, about 16 miles from Cairo, had been completed, and they expected much business from that connection. There was considerable competition in Egypt, and it was necessary that they should provide means whereby they might utilise the concessions they had obtained. After consulting the principal shareholders, the directors came to the determination to ask this meeting to pass a resolution to extend the borrowing powers of the company from £5,000 to £20,000, and they proposed to create debentures to that amount, of which, however, they would only at present issue £10,000. Of this sum portion would be required to pay off a loan they had from the Oriental Company, and the remainder would represent working capital. It would not be consonant with good policy to let any chance slip of increasing their business by reason of any delay in having to ask the shareholders for the means to carry out any extension of business, and it might not prove convenient to the Oriental Company to continue the loans from which this company had hitherto derived benefit at very moderate interest. It would be observed that, including the loan referred to, now about to be paid off, they had spent about £10,000 in new construction, over and above the capital issued for the acquisition of the business as a going concern. As this total value represented £70,000, earning some 6 per cent., the investment in debentures at 6 per cent., with such security, would be an undeniably good one, and they ought not to have any difficulty in placing these debentures. It might be asked why they carried forward so large a sum as £665, which represented 1 per cent. of the preferential capital. But they would observe that while their gross business had extended some 50 per cent., the mean value of each subscription had decreased, and they felt it safer, therefore, to carry forward a substantial sum. The decrease in the rate of subscription, of course, popularised the convenience which the telephonic business represented, and it would be satisfactory if it were more than counteracted by the extension of the business. The chairman then moved the adoption of the report and accounts and the payment of a dividend of 6 per cent. on the 13th inst., free of income tax.

Mr. Grëwing seconded the motion, which was agreed to unanimously.

The Chairman further moved "That in accordance with Article 60 of the Articles of Association, subsection (a), the directors be and they are hereby authorised to raise money by the issue of debentures to an amount not exceeding £20,000."

Mr. W. Addison seconded this resolution, which also was carried unanimously.

The retiring director, Mr. Grëwing, and the auditors, Messrs. Price, Waterhouse & Co., were re-elected, the meeting, after the usual votes of thanks, thereupon terminating.

The German Union Telegraph and Trust Company, Limited.

THE report of the directors for the 12 months ending December 31st, 1887, states that the total receipts during the 12 months amount to £15,368, which, with a balance of £31 brought forward from last account, make a total of £15,399. The expenses for the same period amount to £892; of this sum £750 is provided by the German Union Company of Berlin. Out of the receipts an interim dividend of 5s. 9d. per share was distributed on January 17th last, and the directors recommend the payment of a further dividend of 8s. 3d. per share, making a total distribution for the year of 14s. per share, free of income-tax, or at the rate of £7 per cent. per annum (as against £6 paid last year), leaving a balance of £156 3s. 5d, to be carried over to next account. The proposal of the Imperial German Government for the acquisition of the cables and property of the Berlin Company has been accepted, and an agreement on the terms sanctioned by the extraordinary general meeting of this company of November 28th, 1887, has been entered into, subject to the formal approval of the Reichstag, which is daily expected. The result of the agreement will be, so far as can at present be foreseen, that the Berlin Company will begin to go into liquidation in April next, and that the shareholders of this company will receive a return in respect of their capital early in 1889, when the Government will pay the purchase money. The exact sum to be paid to the shareholders of this company cannot be determined at present, but it will probably be about par, that is £10 per share, less expenses of liquidation, which will make a fractional reduction.

German Union Telegraph Company, Limited.—The directors have declared a final dividend of 8s. 3d. per share, free of income-tax, for the year 1887, making the total distribution 14s. per share, or at the rate of 7 per cent. per annum.

TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company, Limited. The number of messages passing over the lines of this company during the month of February was 4,728, estimated to produce £3,600, against 2,822 messages, producing £3,009 in the corresponding month of last year. The receipts for the month of November, estimated at £3,000, realised £2,908.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending March 2nd, 1888, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,766.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 29th February are £3,139, as compared with £2,840 in the corresponding period of 1887. The November receipts, estimated at £5,236, realised £5,314.

The Great Northern Telegraph Company, Limited. The receipts for February, 1888, £20,400; January 1st to 29th February, 1888, £41,800; corresponding months, 1887, £39,600; and of 1886, £38,680.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of February were £1,858, against £1,623 in the corresponding period of last year.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for week ending March 2nd, amounted to £4,435.

NEW PATENTS—1888.

2772. "Improvements in electrical safety appliances." K. W. HEDGES. Dated February 24.

2784. "A method of and apparatus for electrically lighting railway and other carriages." J. IMRAY. (Communicated by R. Imray, South Australia.) Dated February 24.

2785. "Improvements in holders for electric glow lamps." E. F. H. H. LAUCKERT. Dated February 24.

2794. "Improvements in electrical firing keys or contact makers." C. A. McEVOY. Dated February 24.

2808. "Electro-magnetic conductors for electric and magnetic machines, induction coils, transformers, &c." H. F. JOEL. Dated February 25.

2819. "Improvements in electrical measuring instruments." F. H. NALDER, H. NALDER, C. W. S. CRAWLEY, H. J. PAYNE. Dated February 25.

2883. "Lighting a lamp from the incandescent wire of a galvanic battery." H. F. RICHARDSON. Dated February 27.

2933. "Improvements in mechanism for regulating the force of dynamos or magneto-electric generators." H. J. HADDAN. (Communicated by W. S. Hill, United States.) Dated February 27.

2956. "Automatic electrical fog signalling on railways working in conjunction with the present block system." A. B. HARRIS. Dated February 28.

2958. "The production of musical tones directly by electricity, and the application thereof." J. ESHELBY, E. ESHELBY. Dated February 28.

3041. "An apparatus for attaching to automatic delivering machines, for regulating and governing any required time for lighting or igniting cigars and cigarettes by electricity. E. E. ATKINS. Dated February 29.

3072. "Improvements in automatic electric induction apparatus." H. W. RHOADS, F. W. TICEHURST. Dated February 29.

3075. "An improved clutch for regulating feeding rods in electric arc lamps." A. W. SOUTHEY. Dated February 29.

3097. "An improvement in holding the plates of secondary voltaic batteries." B. M. DRAKE, J. M. GORHAM. Dated February 29. (*Complete.*)

3149. "Improvements in galvanic batteries." L. KAYSER. Dated March 1.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1886.

990. "Improved means for feeding electric batteries and for removing the plates therefrom." S. W MAQUAY. Dated January 21. 1s. 1d. Relates to improved means for feeding electric batteries with the desired liquid during such time as the current is being used, and for stopping the feed and removing the plates or electrodes when the current is no longer desired. The battery cells are fed from a tube connected through a suitable valve with the main supply. The plates or electrodes are carried by a counterweighted lever, and this as well as the valve in supply pipe are actuated by means of electro-magnets placed in circuit. When the current is being used the plates or electrodes are in the cells, and the valve in the supply tube is open and a regulated quantity of the necessary liquid is being fed to the cells. When the current is cut off and the circuit broken the valve is closed and the plates raised until nearly clear of the solution, or to such a position as will still give enough strength to the battery to enable the electro-magnets to act and cause the plates to be lowered and the valve opened when the circuit is again completed. The claims are 3 in number.

2602. "Improvements in the production of aluminium and of alloys of aluminium and copper by electro-deposition." C. A. BURGHARDT and W. J. TWINING. Dated February 19. 6d. Claims:—1. The obtainment of alloys of aluminium and copper by means of electricity from solutions prepared as and in accordance with the methods set forth. 2. In the electro-deposition or manufacture of alloys of aluminium and copper the employment of a double cyanide solution prepared by dissolving alumina in a solution of chloride of copper, and treating the mixture substantially as described. 3. The employment of caustic soda or caustic potash for the purpose of causing the aluminium and copper to combine together in the solution and thus to form double cyanides of aluminium and copper, substantially as described.

3990. "Improvements in micro-telephonic transmitters." C. CLAMOND. Dated March 16. 8d. Claims:—1. In microphone transmitters, the arrangement within a small area of a considerable number of balls contained in cavities in a fixed conducting block and so arranged as to bear by the action of gravity against the vibrating diaphragm, so as to connect this electrically with the said block. 2. In microphonic contacts such as are referred to in the preceding claim, arranging the contact balls in their cavities in such manner that the centre of gravity thereof always lies beyond the edge of the cavity, so that they are caused by the action of gravity alone to bear against the diaphragm. 3. The described arrangement of bent commutating lever which is actuated by the introduction into the casing and the removal therefrom of the telephonic receiver. 4. The combined arrangement of micro-telephonic apparatus constructed and operating as described.

5509. "Improvements in electric arc lamps." A. J. BOULT. (Communicated from abroad by P. J. V. Létang, of Paris.) Dated April 15. 6d. Claims: 1. In an electric arc lamp a mechanism consisting of spring clips provided with jaws at their end which surround the carbon or carbon-carrying rod and clamp or release the carbon or rod according to the position of an inverted cone, substantially as and for the purpose specified and represented in the drawings. 2. In an electric arc lamp a regulating mechanism consisting of an electro-magnet, armature, hammer, and a contact piece producing the regulation of the arc by repeated shocks or tremblings, substantially as and for the purpose specified and represented in the drawings.

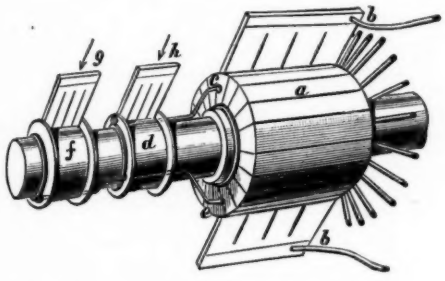
7202. "Improvements in or relating to electric telegraphs." A. J. BOULT. (Communicated from abroad by J. F. McLaughlin, of America.) Dated May 17. 1s. 1d. A series of metallic keys carrying the desired letters or characters, are suitably mounted upon a key-board on the top of the cylindrical casing of the instrument, so that the depression or detent of any one of them will cause the contact of one of a series of retracting springs, charged from a conveniently situated constant battery, with another of a series of upwardly projecting metallic springs, connected at their lower ends with a system of circularly arranged conducting segments, corresponding in number and relative situation to the number of keys of the keyboard; thereby closing the circuit from the battery, and conducting the impulse or current through the segments to a rotating brush arm rigidly keyed to a central revolving indicator shaft, driven by electromotor and carrying another external parallel arm at its upper end arranged in line with the brush arm inside the casing, and pointing to the corresponding character of the keyboard, as indicated by the contact brush on the segments. When the current passes through the inner brush arm attached to indicator shaft, it is conducted through said shaft, to another stationary contact brush arm fixed to the side of the casing, and passes on over the line circuit, to the stationary metallic brush arm of the transmitter located at the other end of line, up through central indicator shaft, along rotating brush arm; and the segments and super-incumbent springs being raised up against retracting springs, the current passes through the springs (they all being in contact and the brush arm rotating in contact therewith) out down to a suitable switch, the contact lever of which is properly adjusted, thus the current traverses through said switch, and up around the transmitter into an electro-magnet which is located in proximity to soft iron disc also rigidly keyed to indicator shaft, said magnet having the converted lower pole brought around in line and above the upper pole, the disc will in its revolution, rotate through the central line between said poles, and the current previously described as having energised the magnet causes the attraction of said disc thereby stopping the rotation of indicator shaft, with the two parallel arms attached thereto, respectively, at the segment and key corresponding to the key depressed at other end of line. This current then escapes from magnet by a second wire, which connects with switch, the lever of which being properly pointed, allows the current to pass therethrough on to ground, or said current may be utilised to operate the local receiver by suitable switch and wire connections. Each key, retracting spring, contact sping, and segment corresponds to a letter or character of the keyboard, and the release of any of said keys breaks automatically the line circuit. The claims are 33 in number.

7506. "Improvements in and connected with electric batteries and lamps suitable for miners' use or for analogous purposes." THE NEW PORTABLE ELECTRIC LAMP AND POWER SYNDICATE COMPANY, D. URQUHART, and B. NICHOLSON. Dated May 23. 8d. Claims:—1. An electric battery consisting of elements of tin or of iron in conjunction with elements coated with or carrying chloride of silver, both immersed in an electrolyte of a solution of soda or potash, substantially as described. 2. An electric battery consisting of elements of zinc in conjunction with elements of peroxide of silver, both immersed in an electrolyte of soda or potash solution, substantially as described. 3. An electric battery

with elements respectively of chloride of silver and tin, in an electrolyte of dilute hydrochloric acid, substantially as described, 4. The combination and arrangement of parts constituting an electric battery, as described and illustrated. 5. The combination, construction, or arrangement constituting a portable electric combined battery and lamp, substantially as described and illustrated. 6. The revivifying of elements of electric batteries in or on which chloride or peroxide of silver is used, by subjecting the elements to the action of an electric current in a chloridising or oxidising bath, substantially as described. 7. The revivifying both of the electrolyte and the negative elements of electric batteries on or in which chloride of silver or peroxide of silver is used, and in which batteries the said elements have been used with positive elements of zinc or iron in an electrolyte of soda or potash solution, or with positive elements of tin in an electrolyte of dilute hydrochloric acid, the said revivication being effected by subjecting the negative elements to the action of an electric current in a bath of the spent electrolyte of the battery, substantially as and for the purpose described.

7577. "Improvements in electric railway cars." N. H. EDGERTON. Dated May 25. 11d. Has relation to street or railway cars which are propelled by electric motors, and it has for its object to so locate the motors and support the running gear of the car, that the power of the motor is applied directly to the axis of the car to reduce the friction and traction between the motors and the running gear and admit of the efficiency of the motors being expended mainly in propelling the car and its load and not being unduly wasted in overcoming the traction and friction between the motors and the running gear, especially so when the cars are propelled or are travelling around curves or other like sections of the road whereat the friction between the tracks and the running gear is usually considerable. The invention has for its further object to elastically support the cars independently of the motors and the axles. The claims are 19 in number.

7818. "Improvements relating to commutators for electric generators." C. COERPER. Dated May 28. 6d. Relates to commutators for electric generators, and is designed to provide means whereby continuous current machines can be used to give off alternating currents, or whereby alternating currents can be used for the transmission of power, or can be transformed, or converted into continuous currents. In order to use continuous current machines to give off alternating currents, the following device is employed. The current collector, *a*, of a two-pole continuous current machine is represented. It is assumed that the brushes, *b*, *b*, commutate the magnetic field of the machine in parallel with the armature, that is to say, a shunt machine for a continuous current is concerned. Two opposite strips of the current collector are conductively connected with two insulated



sliding rings that turn with the machine, in the present case the strip, *c*, with the insulated ring, *d*, and the strip, *e*, with the insulated ring, *f*. If a machine thus commutated is driven, the two sliding springs or brushes, *g* and *h*, send alternating currents into the external circuit. In multipolar machines, all the armature coils that have like position, with regard to magnetic fields of like polarity, must be conductively connected with each other, either by a conductive connection of the respective coils themselves, or of their conducting wires passing to the current collector, or the corresponding strip of the latter. A machine thus commutated can accordingly be used not only to give off alternating currents from the sliding springs, *g* and *h*, but also to produce a continuous current from the brushes, *b*, *b*. There are 3 claims.

8856. "Improvements in apparatus for measuring electric currents." H. ARON. Dated June 20. 8d. Relates to improvements in apparatus for measuring electric currents, described in Patent Specification No. 6770, dated April 24th, 1884. The claims are 5 in number.

8926. "Improvements in printing telegraphs." S. VAN BUREN ESSICK. Dated June 22. 1s. 6d. Consists in an improved arrangement of the type wheel and escapement, whereby half the number of teeth on the scape wheel are dispensed with, and the speed of the rotary movement of the type wheel correspondingly increased. It also further consists in an arrangement of the paper carriage and feeding mechanism whereby the message may be received in successive lines on the strip or sheet of printing paper. It also further consists in a commutator or pole changer of novel construction, whereby a positive action is secured. It also further consists in novel means for holding the circuit closed while the key is depressed, and in the introduction of a pole changer or commutator into the line circuit, by means of which the action of both the transmitting and receiving instruments is controlled by the line current at the same instant. The claims are 22 in number.

9013. "Improvements relating to dynamo-electric machines." C. COERPER. Dated June 24. 8d. According to the present invention the inventor reduces the heating and the loss of power in dynamo machines to a minimum, by making the cores of the armature, as well as the field magnets, of thin sheets of metal. The claims are 3 in number.

9517. "Improvements in arc electric lamps." F. DE WOLFFERS. Dated July 5. 8d. When an electric current traverses the system, the carbons being separated, a solenoid is excited and raises a core, so that contact is made between the carbon points, the force of the solenoid then diminishing considerably, the core descends, the points are separated, and the arc is produced. The consumption of the carbons lengthening the arc, its electrical resistance augments, and thus causes a more powerful current to pass in the coils of the shunt solenoid, the iron core then rises until a contact piece touches a contact piece. The circuit of coils is then closed, an intermittent or alternating current traverses them, and an iron carbon carrier being magnetised by the said current, an intermittent or alternating polarity manifests itself in that portion of the said carbon carrier which lies between the two coils, and opposite to an armature carried by a brake. Consequently assuming the current to be intermittent, the armature is attracted each time that the current passes and the attraction overpowering the tension of a spring, the brake quits the carbon carrier, leaving it free to fall, and at each interruption of the current, the brake is again pressed by the spring against the said carrier, thus stopping its downward movement. As the interruptions of the current follow each other with considerable rapidity a vibrating movement of the brake is produced, which allows the upper carbon carrier to descend very slowly until the arc has reassumed its normal length. The current in the solenoid is then diminished so that the iron core descends, and the contact between the contact pieces is broken. The intermittent current then ceases to pass in the coils and the vibrations of the brake, and the downward movement of the upper carbon carrier is arrested. The claims are 6 in number.

9726. "Improvements in armatures for electric generators." W. P. THOMPSON. (Communicated from abroad by G. Westinghouse, junior, of America.) Dated July 12. 8d. Claims:—1. In an electric generator, the combination with the field-magnets of an armature having its alternate coils wound in opposite directions, and the outer end of each coil connected with the inner end of the succeeding coil. 2. In an electric generator, an armature having its alternate coils wound in reverse directions, and the inner ends of each coil connected with the outer end of the succeeding coil throughout the entire series of armature coils, or any portion of such series. 3. In an electric generator, a series of armature coils, the alternate coils being wound in reverse directions, and the inner end of each coil connected with the outer end of the succeeding coil, conductors leading from points directly opposite each other in the length of the continuous conductor forming the said series of armature coils, and collecting plates with which said conductors are electrically connected. 4. In an electric generator, an armature wound with two series of coils, arranged in multiple arc, the terminals delivering like currents from each series being united at points approximately diametrically opposite each other upon the armature, substantially as described. 5. In an electric generator, the combination with a multiple field magnet and its polar projections, of an armature revolving within said field magnet, having its conductor formed with coils upon its periphery, of greater breadth than said polar projections, substantially as described.

9727. "Improvements in or relating to commutators for electric machines." W. P. THOMPSON. (Communicated from abroad by G. Westinghouse, junior, of America.) Dated July 12. 6d. Claims:—1. The combination with the collecting rings of an alternate current generator, of contact rings receiving a portion of the current therefrom, a rectifying commutator having its plates or sections connected alternately with the respective contact rings, and contact brushes receiving a continuous current from the commutator. 2. The combination with the shaft and collecting rings of an electric generator, said shaft having a shoulder formed upon it, of a commutator clamped against said shoulder, and two contact rings secured to the respective sides of said commutator. 3. The combination of a rectifying commutator, the shaft of an electric machine carrying the same, two contact rings respectively placed upon opposite sides of the commutator, flanges formed upon said rings adjacent to said commutator and screws for clamping and connecting the respective flanges to the alternate plates of the commutator. 4. The combination with the shaft of an electric generator, of two contact rings, a commutator, contact brushes for said ring and commutator, and a support carrying all of said brushes, which is adjustable in its angular position with reference to said shaft.

9728. "Improvements in electric converters and boxes for same." W. P. THOMPSON. (Communicated from abroad by G. Westinghouse, junior, of America.) Dated July 12. 8d. Relates to apparatus employed for transforming alternating, pulsatory or intermittent primary electric currents, into alternating secondary or induced currents. The claims are 20 in number.

9733. "Improvements in or relating to regulating electric circuits and to apparatus therefore." W. P. THOMPSON. (Communicated from abroad by G. Westinghouse, junior, of America.)

Dated July 12. 8d. Consists in an apparatus whereby a current of variable strength is caused to traverse the primary coil of the converter, and is automatically regulated through the instrumentality of the counter-electromotive force developed within the converter itself, the variations of which force are caused by, and dependent upon the variations of resistance in the secondary circuit. To accomplish this result, there is included in the main or primary circuit of the apparatus, an electric generator which must be capable of producing an approximately constant electric current in a closed circuit of varying resistance together with a regulator, which comprises one or more pairs of differential helices, normally tending to produce equal and opposite magnetisms in a soft-iron core. This is so arranged as to constitute an automatic current-regulating device for the converter proper. The primary coil of the converter is placed in multiple arc with one of these opposing coils. The claims are 12 in number.

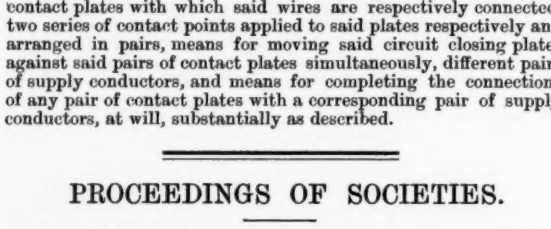
9742. "Improvements in circuit controlling apparatus for electric circuits." W. P. THOMPSON. (Communicated from abroad by G. Westinghouse, jun., of America.) Dated July 12. 8d. Claims:—1. The combination with two or more generators, of two or more pairs of lines, a switch plate for each of said lines, individual switch points respectively applied thereto and connected with the respective generators and means, substantially as described, for placing each pair of lines in connection with the respective pairs of switch plates at will, substantially as described. 2. The combination with a group of generators, of independent pairs of main lines, terminating in individual switch plates, contact plates for connecting the individual switch plates with the respective poles of one of the said generators and independent switches for connecting the generators in multiple arc circuit. 3. A switch or circuit controlling device consisting of a movable lever, two independent contact plates upon said lever, two independent series of contact plates respectively applied thereto, and individual contact plates applied to the last-named contact plates and adapted to be placed in electrical connection therewith at will. 4. A circuit controlling switch consisting of two independent circuit closing plates, two independent series of contact plates respectively applied thereto, corresponding series of contact plates, one or both of which series are normally electrically insulated therefrom, means for completing the connections between any two of the first-named contact plates and their corresponding insulated plates, and means for moving the circuit closing plates into contact therewith. 5. In a system of electrical distribution, the combination of an outgoing and return wire, two contact plates with which said wires are respectively connected, two series of contact points applied to said plates respectively and arranged in pairs, means for moving said circuit closing plates against said pairs of contact plates simultaneously, different pairs of supply conductors, and means for completing the connections of any pair of contact plates with a corresponding pair of supply conductors, at will, substantially as described.

PROCEEDINGS OF SOCIETIES.

The Society of Telegraph-Engineers and Electricians.

(*Continued from page* 244.)

Mr. W. B. ESSON: Coming after a most energetic representative of the anti-transformer party, I have to express my indebtedness to Mr. Kapp for having brought before the society his extremely interesting and instructive paper. In introducing his graphic method of dealing with alternating currents, Mr. Kapp has conferred on engineers a great boon, as treated in this simple fashion, the problems are more easily understood, and the effects of varying the proportions of the apparatus being rendered visible by diagrams, are thereby more readily comprehended. I observe, however, that Mr. Kapp throughout his investigations assumes that the E.M.F. impressed on the primary circuit, or E.M.F. generated in the dynamo, is a sine function of the time, but in modern machines with iron cores in their armatures this surely is not the case. I can understand that in the Siemens dynamo a curve of sines represents the E.M.F., or that in a dynamo like Ferranti's the deviation may not be great; but I do not think



that a curve of sines represents even approximately the state of things in a dynamo which, like Mr. Kapp's, has a disc armature with an iron core revolving between two series of magnets. This matter is of the greatest importance. I have endeavoured to map out the field of a dynamo similar to Mr. Kapp's, and obtain for the E.M.F. the curve, B, which, as will be seen, departs very much in form from the sine curve, A. It is possible that the flat part in the diagram is more extended than it might be, but that there is a flat part of considerable extent is certain. I do not say that this fact detracts from the value of Mr. Kapp's method of treatment, though it must influence to a certain extent the results obtained. In both geometrical and mathematical investigations something must be assumed as a basis in the absence of experimental data. Mr. Kapp assumes a curve of sines to represent the E.M.F., and the question arises to what extent are the results he obtains modified by the actual curve, taking instead of the form A the form B. My opinion is that the only reliable way of proving the advantage of one type of transformer over another is to construct and try the actual apparatus on a circuit. The results of Mr. Kapp as regards the degree to which the saturation of transformer cores may be pushed are most valuable. It appears that the best results are obtained from a density rather less that 10,000 C.G.S. lines, or half that employed in saturating the armature cores of continuous current machines. I should be glad if Mr. Kapp would tell us the usual weight of transformers now-a-days per 60 watt lamp, and how many volts he gets per foot of conductor. In the Westinghouse transformer there are obtained, I think, 2 volts per foot. There seems to be very little difference in the construction of some of the transformers exhibited, though the object in some cases appears to have been not so much improvement as variation. The transformer of Kapp and Snell has, I think, an advantage over most, in that the cover can be taken off and the coils removed without taking the whole thing to pieces. In those transformers in which the iron part is interlaced into the conductor part this cannot be done. But the advantage may not be a very important one. Leaving the transformers and coming to the question of distribution, there seems to be here some difference of opinion. I understood Mr. Bernstein last time to express himself in favour of the series system, and from his paper it appears that Mr. Mackenzie is favourably disposed towards it. The table published three years ago and given in the second paper shows that transformers coupled with their primaries in series give in the secondaries a current practically constant, and so far then as self-regulation is concerned the series and parallel systems are alike. But when we consider the cost of the conductors it turns out that those required for the series system are the more expensive. Throughout the system the same section of conductor has to be maintained, and if 10 lamps are required 100 yards down a street the heavy cable has to be taken there and back the same as if there were 100 lamps instead of 10. I do not understand Mr. Kapp's remark that in sparsely lighted districts the series system would be cheaper. Of course, if the same total weight of copper is used in the conductors with the same current density and the same E.M.F. employed at the generating station the loss of power would be the same. Mr. Kapp probably means that in the series system if it were cheaper to save copper at the expense of power it is permissible to do so, since the regulation in the series system would not be thereby affected. I am afraid I don't think much of the Kingdon dynamo for reasons already referred to by Mr. Atkinson. The magnetic circuit should not be subjected to abrupt changes of section as the machine is working, but the flow of lines should be uniform, otherwise Foucault currents will be generated. It would only be by a great degree of lamination that heating could be prevented, and that means a rather expensive machine. In conclusion, I have been much puzzled by the last sentence in Mr. Kapp's paper. I am not quite sure whether it is intended to be prophetic or not. If Mr. Kapp believes that a storage battery sufficiently reliable to be depended on will be forthcoming, it would be a pity, though, having the conductors all ready, to find himself with the wrong kind of dynamo at the generating station and the transformers rendered useless. I would advise Mr. Kapp to prepare for the contingency of a good battery by abandoning the alternating current altogether, and putting down continuous current high potential dynamos at the generating station and continuous current transformers at the sub-stations. He would then be ready for the battery when it arrived. The lamps would be worked from the transformer, the battery being used as a stand by, and the leakage only being made up by occasional charging from the transformer. The continuous transformer system might not be quite so efficient as the alternating transformer system, but it would be more efficient than charging and discharging accumulators. Its efficiency would be between the two, and nothing would have to be thrown away when the long-wished-for battery arrived.

Mr. SYDNEY EVERSHED: Mr. Esson has anticipated a few of my remarks in his protest against the employment of the sine function. There is one very good reason for employing it, however, and that is that it is the only one which can be worked mathematically. It is rather remarkable that the sine function is, so far as I can see, the only one which is reversible, *i.e.*, that the secondary current will also be a sine function of the time. Mr. Kapp says that he has reason to think that the curve of E.M.F. of whatever shape produced by a machine will, after filtering through two or three transformers, come out as a true sine curve. Of course Mr. Kapp with his beautiful geometrical method, hopes that it would come out as a true sine curve, but I am afraid the facts are against him. I think the effect of filtering it through one transformer—and one would be quite sufficient if the original curve departs in any way from the sine curve—will be to make it depart still more from the sine curve. However, as Mr. Esson said, that does not really detract from the merit or method of Mr. Kapp's paper in the least, though it does in some

way detract from the results obtained. Mr. Esson has been good enough to give us a diagram of one of the curves, and it shows what a complicated function a modern dynamo may give. The Westinghouse dynamo is supposed to give not a sine curve but an oscillating curve; it is difficult to say from the machines what exactly the curve would be, but it is evidently not a sine function. The only way I can see of taking that function is to assume that it is a hyperbolic function, and I can only echo Mr. Kapp's wish that some one with a mathematical tendency would investigate the subject. If I may, I would like to say a word about a wattmeter for measuring power. Dr. Fleming described a large wattmeter which apparently did not give very accurate results. There is no need for a wattmeter to be large. If Dr. Fleming were to make a wattmeter like those beautiful instruments which he showed at the meeting here last year, and employed in them a very few ampère turns, say 2 or 3, on the pressure coil, and a large number, 100 or so, on the current coil, he would then get an instrument in which there was practically no lag in the pressure coil, and consequently it would give the true instantaneous values. It would give the mean of the true instantaneous values. I have made a wattmeter which worked very well indeed with about 100 ampère turns in the current coil and about 5 ampère turns in the pressure coil, and I should imagine that even Mr. Kapp would not object to 5 ampère turns, when in an incandescent lamp there may be 1 ampère turn, and it is a question of the deduction of one lamp.

Prof. J. PERRY: It has been said by Mr. Esson and by Mr. Evershed that the curve is not a true sine curve, and that therefore Mr. Kapp's theory must be wrong. In this room already I have made a correction of a statement of that kind. I understand that Mr. Esson measured his field, and if you get that curve which has been spoken of, the primary current will be nearer the sine curve than that of the current from the secondary in a transformer. The effect of self-induction and mutual induction is to affect the minor ripples. If we have one sine function of a certain field we can calculate exactly what the effect of self-induction is in toning down. Mr. Esson's curve has a lot of ripples, every one of which is toned down, and the quicker ripples tone down very much lower than the slower ones, and the result is that passing through a transformer I do not see that it is possible by any method of measurement to get anything very different from a true sine curve.

Mr. W. M. MORDEY: The opposition to transformers on the part of Mr. Gordon and Mr. Crompton rather reminds me of the historical gentleman who tried to keep the tide back before it had got to the top, but I think with this difference, that Canute knew that the tide would not stop, and I do not think Mr. Crompton and Mr. Gordon do. There is no doubt whatever, from what we have seen on the other side of the Atlantic, at any rate, that transformers have a very great future before them. Mr. Kapp will excuse me in referring to points in the discussion before touching on his paper, but Mr. Crompton said that the bottom would be knocked out of his argument if it could be shown that small alternating-current dynamos could be used in parallel. It is easy to knock the bottom out of that argument, because dynamos have been so worked, not only in land lighting, but across rivers; a lighting station in the States on one side of a river has supply mains connected with a network on the other side as well as on its own side, and when it is necessary to put more power into the mains, the dynamos on the other side of the river are switched in. I do not think there is any serious difficulty in doing it. One objection I should like to make in regard to the remark at the conclusion of Mr. Kapp's paper about the use of a network in transformer systems. It seems to me that the great advantage that we have in transformers is that we get rid of the enormous cost of the low tension network. Everybody has known that the cost of the copper in the low tension distribution system has been a very serious item of old, and at the same time that as transformers regulate so perfectly; as they can be made to regulate, even more perfectly than they do just in their simple state; and as they are undoubtedly very efficient indeed for small loads, and further as the loss in the main conductors can be at a practically negligible cost rendered of scarcely any effect whatever, we get rid entirely of any necessity for a distribution network. We only want a distribution network to help one part when the wires to it are not sufficient to carry the full current. I also disagree with Mr. Kapp as to the advisability of having separate transformers in every house. It may not be necessary to have them in every house, but I certainly think that if some arrangement is made for cutting out a transformer when anything goes wrong with it—and there are several such arrangements—the very best thing we can do is to put a number of transformers right along the mains, and just cut out one house and no more when a transformer in that house goes wrong. I would go further: in putting wires in a large hotel I would put transformers at different points and carry the primary mains round outside, and to that extent perhaps a network system might be used. The advocates of the series connection of transformers forget that there are two difficulties. One is, that the regulation of a constant current system with alternating dynamos is not at all easy. I do not know that it has been done yet. We can regulate—a good many people say that we cannot—but we can regulate and maintain a constant current on a direct current system; but for an alternate current system the regulation of the transformer alone only solves one portion of the problem. We must have the current constant in the first place, and when that is obtained, it has been shown in two ways, by using lamps in series, and by using Mr. Kent's ingenious arrangement of choking coils, that it is possible to regulate at the lamps. But we have got to start at the station, and we have not got over that difficulty yet. The second difficulty is that in a series system we can only work up to say 2,000 volts, when we must stop and increase our leads, which we may just as well do at the start when all the calculations can be made and provision made without having to solve problems later on. I was glad to hear Prof. Ayrton speak of the calorimeter method of testing transformers. I believe that a calorimeter test, even if very roughly carried out, can be very accurate. About a couple of years ago I tried an experiment of this sort. I took an ordinary packing case and made it watertight, and put a resistance coil in, I sent water through it and sent a current through the resistance. I had the current and the difference of potential, which I did not know, measured, and with an ordinary two-gallon bucket and couple of thermometers I took the temperature of the incoming and outgoing water, and the amount of water in gallons per minute, and working it out I got within 4 per cent. of the actual energy spent in the circuit. That would form a rough sort of wattmeter. By using a water pail and resistance it would be quite possible to find what the energy might be, and that method would be easily applied to an absorption method in testing alternate currents: unfortunately, it could not be used as a transmission method. It has been said to-night that it is not possible to decrease the speed of alternating current dynamos for small loads, because the alternations must be kept the same. May I be allowed to mention a method by which it is possible to decrease the speed and to keep the alternations the same. I do not know that it is a very practical method, but at any rate, it would work after a fashion. If we take an ordinary Gramme machine and put a laminated field about it, and send an alternating current at a given rate of alternations round the field, we should get from the ordinary Gramme machine an alternating current with the same rate of alternations: if the field is kept constant there will be an E.M.F. directly proportional to the speed. By varying the field and varying the speed, it will be possible then, on paper at any rate, to decrease the speed of the machine and to keep the alternations constant. The only thing that would be necessary would be to have a small separate machine to excite the field at a given rate of alternation. May I be allowed to mention an experiment that I made bearing on the subject of lag? Mr. Kapp, with his diagrams, can probably see what takes place in a transformer; but some of us cannot do this. I wanted to get something that I could look at to show the lag, and I should like to submit the method for criticism; perhaps Mr. Kapp will tell me whether it is wrong. In one experiment I had two transformers. The thick wires of the first connected with the dynamo: the fine wire terminals of the same transformer were connected with the fine wire terminals of the second transformer, thus between the thick wire terminals of the second transformer would therefore be produced practically the same potential difference as that given by the dynamo. If now one of the thick wire terminals on each transformer were connected by a short wire, and a voltmeter was inserted between the remaining two thick wire terminals, the voltmeter would indicate either the sum or the difference of the potential difference existing between each pair of terminals. If there were an appreciable lag, the sum would be somewhat smaller than twice the potential difference of the dynamo, and the difference would be somewhat greater than zero. If there were no lag the sum would be almost exactly twice the potential difference of the dynamo, and the difference would be almost exactly zero. I found that this was actually the case. Even when I had six transformers coupled in this way the total potential difference of the first and last coils of the series was the sum of their two potential differences taken separately. The experiments were made with open circuit as well as with a fair load on the transformers, and seemed to show that there was no appreciable lag. I am sure we must all have heard with very much regret of the mental illness of M. Gaulard, and that distressing circumstance makes it difficult to say very much about some of the theories which have been put forward in Mr. Mackenzie's paper. I think, however, one can hardly pass over the statement that it was not until the views of Faraday had been proved to be erroneous that it was found possible to make any advance in transformer work—it is scarcely fair to say that it was only when those views were abandoned that progress began to be made.

M. T. H. BLAKESLEY: Some years ago I gave a method of measuring precisely the phase between two alternating currents, and which has met with such approbation from Signor Galileo Ferraris, that he has done me the honour to claim it as his own. Perhaps I may point out to you exactly what it is. An ordinary dynamometer, as you know, is composed of two coils, one of which is fixed, the other being movable. If those two coils are used in series you can measure the square of your alternating current. You can try this method first to one of your coils and then to the other of your coils, and then if you please you can use one of the currents through one of the coils, and the other through the other; these readings give you, without the slightest difficulty, the cosine of the current between the two phases. Nothing is simpler, and nothing is easier to prove that it is. If Mr. Kapp would try this method on his primary current and his secondary current in his transformer, I think, sir, his mind would be enlightened as to some facts which he has put forward in connection with this subject. He has drawn a line representing the phase of magnetisation in his core, and he has made that correspond with the resultant of the phases of the current in the secondary coil and in the primary coil. In his fig. 4 you will observe that O F is resultant into O P. I say this altogether fails if hysteresis is a fact: if hysteresis is

not a fact, I have nothing more to say on the matter; but Mr. Kapp himself owns that there is a considerable degree of hysteresis in the polarity of a mass of iron. I will point out what I mean: O J^1 and J^1 P, together, make up something which is in the same phase as O F, they make up the magnetic field due to the currents, and that I will allow; but that the magnetisation phase corrresponds with that I deny, and I deny it on this ground: If the magnetisation phase coincides with O P the phase of the increase of magnetisation is at right angles to O F and therefore its projection on O P equals nothing at all; and therefore as these two things are proportional to the hysteresis, the magnetic field and the increase of the magnetism in the magnetic field, since that would be nothing the hysteresis could be nothing, and the magnetisation must follow the field of magnetism produced by the current. In fact, Mr. Kapp has left out from O a certain line which is an induced magnetic field due to the increase of magnetism itself, which is an effect I think not very often recognised; and if he puts that in (in a way that perhaps it is rather too complicated to go into now without much difficulty), he would work out his complete figure without the knowledge of one thing, viz., the coefficient of this hysteresis which is the thing he is seeking. But if he applies this dynamometer method to find the difference between the two currents, the result will be that his figure is completely determinate, and that the hysteresis comes out as a function of those dynamometer observations. I think it is very right of Mr. Kapp to indulge in these geometrical figures. I have done so very largely myself, but I think he is wrong in tracing in the same diagram things of an entirely different sort, fields, E.M.F., and so on. I do not know whether those are the two that he has mixed up, but he has not kept all his lines of the same sort in *that*. If he had been successful in his representations perhaps I should have had to quarrel with him on that account, because I think I started this geometrical phase before he did. But I must entirely disclaim that triangle, J^1 O F, as representing the phase of the magnetic stress and the result of the magnetisation.

Mr. A. WRIGHT: I should just like to say a few words with regard to Mr. Kapp's statement about the superiority of the core transformer over the shell transformer. I think in this he has lost sight of the fact that as nearly all the heat of the transformers is produced in the iron, the iron being outside in the shell transformer is better able to lose its heat than in the core transformer, and therefore if we take that into consideration I think you will find that the shell transformer is very much better than the core transformer. In the core transformer the heat has first to warm the copper, and the perfection of a transformer is low force in volts in the primary and secondary consistent with very small true current passing with the secondary circuit open. In central station work it is very important to have a very small current indeed passing from the primary when the secondary is open, because in the case of all day and all night supply that current will mount up when there are many houses connected on the system. I think it is most important to fully investigate which form of transformer is the better on the basis of comparing the true current; by true current I mean the current passing when the secondary circuit is open. With regard to safety instruments connected to the secondary circuit of a transformer, perhaps the simplest plan would be to connect the secondary circuit to earth through a very high resistance inductionless coil, and when the tension of the secondary circuit got sufficiently high, to make that move a rocker which would short circuit the secondary terminals, and so fuse the primary fuses and cut out that transformer from the rest of the circuit. That is simpler than the electrometer method, and I think perhaps safer than Prof. Ayrton's proposal of putting the secondary circuit straight to earth. The practicability of putting converters outside houses is most important, and I think it ought to be got over by putting the converters in cast iron boxes with water-tight joints, and a very small phial of sulphuric acid to condense any moisture that might arise. I think the danger of having a high tension converter inside a house ought to be considered, and I do not know whether this plan would not succeed as it does in other cases, in electrometers where it is absolutely necessary to get very high insulation. With regard to Mr. Crompton's challenge about the cost of the unit. If Mr. Mackenzie is not going into those figures, I should be very happy to state the figures that we have worked out at Brighton. The cost of the unit throughout the whole year for all sorts of loads can be given and compared with Mr. Crompton's figures. He should take into consideration the enormous cost per unit for depreciation of batteries and attendance, and he must not lose sight of the fact that, in the cost of the unit, management and superintendence mount up to a very large figure. With regard to measuring the efficiency of a transformer by means of a calorimeter, that seems difficult with large machines; it is very difficult indeed to put a 6-unit or 7-unit transformer into a vessel of water without losing a great deal of heat by radiation at the sides of the transformer. It is a bulky instrument, and of course that size of transformer is the most important to find out the efficiency of. As to Mr. Kapp's suggestion for having one transformer to every house or one to many houses, that I think depends upon how the houses are situated. In systems of electric lighting it will be very difficult for the next two or three years to get a number of consumers close together; when that happens, and you get two or three customers close together, by all means put one converter for that group, but for many years to come I do not think that will be the case. It means having separate converters for every house for some time, because house to house lighting, lighting every house in a street, I think is very much in the future, we cannot look forward to that yet.

Mr. MANVILLE thought that hardly sufficient justice had been done to the work of Jablochkoff and others.

Prof. SILVANUS P. THOMPSON: I cannot quite agree with Mr. Kapp in dividing transformers into core and shell transformers. Where does one begin and where does the other end? Where does a core become a shell and where does a shell become a core?

After criticising Mr. Mackenzie's paper, the speaker proceeded: Now I come to a remark from Mr. Crompton that I really feel ought not to go unchallenged. He says we must work something under 500 volts. Why does he not take 5,000 volts or 10,000 volts? Because his dynamo will not do that. Fancy 2,000 volts on an ordinary commutator made up of parallel bars; we know it may last for a trial run, but for how many years will it run? The first machines with commutators made of mica had to go back to the shop every time they were used, and we have to find out some other means for working with a current of 5,000 volts or 10,000 volts, so that Mr. Crompton has reasons for limiting it.

Mr. J. E. H. GORDON: How about the brush machine?

Prof. S. P. THOMPSON: The commutator is different. So is that of the Thomson-Houston machine; so are they of the constant current machines that will work at 2,000, 3,000, or 5,000 volts. Mr. Crompton limits them to 500 volts.

Mr. R. E. CROMPTON: Why should you not use that?

Prof. S. P. THOMPSON: Because it is obvious that the main reason for transforming is to go from a high to a low tension.

Mr. J. E. H. GORDON: Everything is as the square of the volts, and you have got the limit already.

Prof. S. P. THOMPSON: Yes, it is found possible to go further with alternating current machines. Alternating current machines are not to be compared with continuous current ones—they take up so much room, they are not so useful, and will not work in parallel. I am afraid that Mr. Crompton is not up to the latest alternate current machines, or he would not say what he does. I happen to know that there are alternate current machines, and we may hear of them in this room soon; as the continuous current machines are better than those of five years ago, so the same kind of improvements have been introduced with the same happy results. As to machines not working in parallel, we have had indication enough on this point in this room to-night from Mr. Blakesley and Prof. Perry. If two coils are put into the circuits of the two machines, so long as there is similarity of phase there will be similarity of action between those two coils, and directly they get out of phase, obviously a spring can be introduced to regulate the action. There are other ways of doing it, but I suppose they have not simply been worked out, because there has not up to now been a demand in that direction. As to the time function, I have pointed out on more than one occasion that the question of the curve obtained for the curve of induction in the machine is a question of the shape of the pole pieces. The machine does not give a sine curve: It is perfectly true that the self-induction of the circuits, in every part of them acts, as I have said before, as a harmonic flywheel, to flatten down the ripples to produce a harmonic period, and with all due deference to Mr. Esson's curve, it is perfectly clear if the machine gave no curve for its curve of self-induction, that its pole pieces might have been better shaped to fit something different. I would like to say that I have no great love for alternate currents. If I have differed from Mr. Crompton to-night, it is not because I do not think storage is itself, in the abstract, a great deal better, but I do not in this state of things want to see any difficulties unnecessarily put in the way of the fullest and most complete trial being given to the system of distributing alternating currents by transformers. Lastly, I am very sorry that I have not heard to-night mention made to any extent of continuous current transformers, I mean motor dynamos. That appears to me to be a real success where it has been carried out. I am sorry we have not had some contribution from Messrs. Paris & Scott in this debate to tell us how they carry it out, because we know so little about those machines. One extraordinary property they have is that when they are doing their work with the current of the coil of the incoming armature, and that of the outgoing armature, the same effect is produced as is obtained from a transformer; the self-induction of the two separate coils is practically wiped out by the mutual induction between the two when the machine is fully at work, and the consequence is that these machines hardly spark at all when doing their heaviest work. It is clear that in all directions distribution by means of transformers is the order of the day, and whether it be by alternating current machines on the one hand, or by accumulators on the other, or by motor dynamos, it is clear that transformers will be the means of distribution.

Mr. KENT: I should like to ask Mr. Mackenzie what he means when he says that the secondary current increases as the square of the ampère value of the primary; perhaps he will give us further particulars.

Mr. GISBERT KAPP, in reply, said: I will make my reply a little discursive. In the first place I will answer Prof. S. P. Thompson's question as to the distinction between core and shell transformers. The explanation is already given in the paper; a shell transformer has one set of coils and two cores or more; a core transformer has one core and two sets of coils or more. About Mr. Wright's remark that a shell transformer is superior. I quite agree with him, and that is why I make mine a shell transformer, but I did not say that the Zipernowski transformer was superior; it is inferior, being a shell transformer of a circular ring type. A very interesting experiment was sketched by Mr. Mordey showing that there is no lag, and that is what I say, that the angle, a, in my diagram, when worked out for a transformer, is perhaps one

or two degrees of the cosine, 9·999, so that, as can be imagined when a large number are added together, say six, an appreciable difference is obtained; probably there is a difference, but the error of the measuring instrument may allow for that, and therefore Mr. Mordey appears to have arrived at the exact sum. Now about the cost of the network. I object to putting transformers in the houses simply on account of safety. I think that whatever we do we must study safety before the coal bill, and every other consideration, and as long as you have transformers in the house lamps are not safe; children are inquisitive, and will climb about and put their hands on the terminals and do other things. That is the reason why I advocate putting transformers outside, and we should have the further advantage that when one broke down the other houses would not be put in darkness. You are bound to have a network, but instead of having the huge main, which Prof. Forbes brought before us some years ago, something like 10 yards wide and an inch thick, through our streets, we shall have mains of ¼ inch section, they will be exceedingly small and will not cost even as much as Mr. Crompton's very cheap mains, 18s. 6d. a yard. That is the reason I advocate a network. Now comes the other reason, that is, if you have the network once laid down, you can use it when the happy day arrives that you have a battery. A question was asked by Mr. Esson about the weight of transformers. That depends entirely upon the size. This transformer now before you weighs 1½ lbs. for every lamp; the transformer which Professor Ayrton tested weighs 2 lbs. for every lamp, and 1½ lbs. per lamp may be taken as the average for 150 lamps, and 1 lb. for each lamp for a 500 lamp transformer. I now come to the remarks of Mr. Gordon and of Mr. Crompton. I must confess that when I heard those two gentlemen speak, I began to feel very doubtful whether, after all, we were not on the wrong line. But I was comforted by the idea that supposing even such men as Edison and Brush, or Westinghouse, had been sitting here and had seen this diagram, they would have gone home and said: "I will never put up another central station again because of this enormous consumption of current when people go up to dress." But what is the fact: how many battery stations are running in the world? I know of a very small one in London, and I know of a slightly bigger one in Berlin; but I think those are all. A great many dynamo stations are running in the world, I cannot say how many, but I think in America there are something like 1,000, and on the Continent of Europe there are perhaps 130 or 150, and in England their are perhaps 14. All these are working on the direct system, and their machinery must be capable of supplying the extra spurt which we see in the diagram. But this is a bad case. In reality you can only have such a condition of things when you have to light the same class of house throughout the district. But in London we never have districts so defined; we have residential mansions, and within a stone's throw we have slums, and also shops within the arc which would have to be supplied from one station, so that although in this diagram it looks very bad, you will never have to meet such a case, or if it should be met with, all you would have to do would be to make some allowance in the machinery. But in what way is Mr. Crompton better off than we are? He has to supply this extra amount of light: he cannot tell. He may use batteries, but the light is wanted by the customers, and must be found. It is no use saying to us that we have to put up more machinery than I. I say all right, you have to put up more batteries than I, and it is the batteries that cost the money in an installation, not the engines. I am not against batteries in any way. I would hail the day with delight when we get a good battery; but all the arguments that were used to-night by Mr. Crompton and Mr. Gordon might have been used with equal consistency three years ago. We knew the batteries; we had batteries then, we had very good direct acting steam engines and dynamos, why did not they come forward and light by that means.

Mr. CROMPTON: We had no good battery.

Mr. GISBERT KAPP: Have you any in use? I saw some at the Colonial Exhibition, but they gave an efficiency of only 16 per cent.; they were supervised by an efficient staff. No transformer need work at less than one-third of its output, for the simple reason that when the output gets so low you cut out a feeder and take the output from different points. The point about running dynamos in parallel has already been answered, and that finishes the whole argument about having a big compound engine to do little work; you would have the engine running according to the power, 1 for a little and 4 for the maximum I should like to say one word about the question of dynamos. I am afraid you will go away frightened at the size of alternating current machines if you take Mr. Gordon's figures. He gives a machine for 200 kilowatts with an armature 10 feet in diameter. Now, the machine which was shown last Thursday on the board is a 60 kilowatt machine and the armature is 40 inches in diameter. If you build a machine on the same lines with a 5 feet armature it will give 300 kilowatts, and the machine would weigh about 80 lbs. per horse-power, which is less than a continuous current machine. Time is getting on so I must be very brisk. I come now to the discussion of last Thursday. The calorimetric measurements of Prof. Ayrton are, I think, very interesting, and as far as I know they are the first exact experiments that have been made. There is one point in such experiments, however, to which attention should be paid; that is, the temperature of the room in which the calorimeter is used should be about the mean temperature of the incoming stream of water, so that the radiation of the room may be nothing. That can be always done, because you can regulate your flow: suppose your room is 15° C.; if the incoming water is 10° C., that is a constant, and the flow can be regulated so that the outgoing water should be at 20° C., then the incoming temperature would be the same as that of the room, no heat given and none taken away, every measure is accurately practical in the calorimeter. I am told by Prof. Ayrton that that precaution was adopted. Several speakers to-night and also last Thursday spoke about the magnetic lag. They say there is magnetic lag, but it will be a bold man who can say whether there is or not, because nobody has tried it. But I think there is not. My reason for so thinking is that if there were magnetic induction lag I cannot see how any telephone could articulate. If there were lag, the lower the voice going through the telephone the better the hearing. Now, as a matter of fact, you hear the "high" voices better than the low voices. Now the high voices have quick waves and should be more distorted by the lag; they are not more distorted, and for this reason I am inclined to think there is no lag, and until somebody shows me by actual experiment that there is, I think I shall stick to that opinion. Objections were stated by Captain Cardew and Mr. Bernstein to the safety device which is put between the two coils, and Mr. Bernstein characterised it as something which leads the primary current into temptation. Now, what is the temptation? It consists in the presence of a metal outside the primary coil, but between this metal and the primary coil there is insulation. Now, in what way does this differ from the temptation which exists in the transformer which has no such sheet? You have metal in the secondary coil, and you have insulation between it and the primary, which is just the same thing; and in what way is the strain brought on the primary greater on account of this dividing sheet than of the strain which is already brought about by the presence of the core itself? You are bound to have iron somewhere, and whether you have it on the inside or outside, the strain on the insulation is just the same, so I believe the objection is really sentimental. A very interesting question was raised by Mr. Bernstein as to which was the most economical transfer as regards output, series or parallel. That depends entirely upon the ratio between the waste going on in the iron and in the copper. When you work in parallel the magnetisation of the iron is a constant, and therefore the heat generated in the iron is a constant for all loads. When you work in series the magnetisation of the iron is very little when the work is little, but the heat generated in the copper is a constant. If we deal with two transformers, and the heats generated in the copper and the iron at full output are equal, then they will be also equal; the efficiency will be the same in both cases at low output, but inasmuch as generally the heating of iron is more than the heating of copper, the series transformer will be slightly better in efficiency for low output. A suggestion was made by Dr. Fleming which I was very glad to hear, viz., that experiments should be made. I only hope somebody will give money enough to carry out the experiments he wants, so as to try what is the permeability of iron at different periodicities. That would be interesting in itself, but a very more important question would be, what is the heat generated in iron with different degrees of magnetisation and a different number of alternations per second; that is the real question which regulates the design of transformers. If we only could magnetise our core more than we do now, without producing more heat than we do now, we could make transformers which would be exceedingly small for the out-put. I ought to have mentioned this before when I answered Mr. Crompton. I propose to put down an alternating plant simply because I have no confidence in batteries. If secondary batteries were good enough I should never dream of putting down alternating current transformers, but I have never seen a good battery, and that is what is being done everywhere; and, as Mr. Mordey said, you might as well try to stop the sea as to try and stop alternating current machines. But to provide for the day when batteries are good enough we must put down our plant now so that most of it can be used later on. Let us see what we have to throw away and what we retain. We retain our boilers, engines and plant, the whole of the network and the whole of the distributing plant to houses; what we have to throw away is the alternating current dynamos and the transformers, both of which together will not come to more than 1s. a lamp. The fitting of a lamp in private houses will cost from 30s. to 35s., the conductors would cost something like 30s. again, so that you see by introducing the alternating current, or, as Mr. Gordon calls it, by wasting energy on something which is no good, we shall only sacrifice only 10s. out of a total of about £5 per lamp when the happy day arrives that we get batteries. It appears to me there is no fault to find with it, we do not advocate a thing which is altogether wrong and will be altogether wrong in a few years, but we advocate a thing which, with a very slight sacrifice, will be good for the day when we shall have batteries.

Mr. MACKENZIE, in reply to Prof. Ayrton's query as to whether the coils he spoke of were ever seriously tried at the Grosvenor Gallery installation, could only say that some experiments had been made with an apparatus consisting of a single coil of fine wire placed in shunt to the primary of the series transformers then being used, in which coil was inserted a core formed of a bundle of iron wires, inserted more or less by hand as the output from the secondary of the transformers varied. No good results were, however, obtained, as the coils that were tried invariably got burnt up in course of time. The idea was abandoned, and no further experiments were made, it being decided about that time to put the transformers in parallel. Mr. Bernstein had suggested that his fusible contact plugs would serve as a means of putting the secondaries to earth should the potential rise above what was proper, and he (Mr. Mackenzie) thought that such an arrange-

ment was quite feasible, and would prove cheaper than the apparatus devised by Captain Cardew, which was, however, in itself an excellent and ingenious contrivance; but he objected altogether to putting the secondaries to earth in an installation based on the transformer system, for reasons which were numerous and had already been mentioned by previous speakers. Mr. Atkinson, in referring to the Kingdon dynamo, wondered whether Mr. Mackenzie had experienced, in working this machine, a large amount of alternation in the exciting circuit, and this effect had in reality been observed, though not to any great extent, and was probably due to the causes mentioned by Mr. Atkinson. Mr. Kingdon, in stating that the fly wheel of an engine would form part of his machine, did not intend to convey the impression that existing engines were preferably to be so altered: but that in designing a dynamo for a central station, the fly wheel of the engine, necessary to insure in any case steady running, could be made to form part of the dynamo, and thus combine two functions in one. The object of arranging the machines into various circuits so as to admit of alterations in the coupling was obvious, since bobbins could be cut out of circuit as the output diminished, thus working the remainder at their maximum. There were many reasons why it would be advantageous to be able to alter the connections of the bobbins, but the want of time prevented him going into the matter. In answering Mr. Crompton's request to give him information regarding the efficiency of the transformer system, he thought that Mr. Crompton was at present asking for rather too much. As regarding the saving of copper used by the employment of this system, reference to the diagram on the wall would make this clear, and he thought that many of the objections that had been raised by Mr. Crompton had been met and successfully answered by several speakers that evening. There would be no gainsaying the fact that the transformer system had made tremendous way, and this would never have been the case had not the system possessed merits placing it before all others for the general distribution of electricity. He quite expected to see Mr. Crompton before very long becoming as warm an advocate of the transformer system as he had, not many years ago, been an opponent of electrical distribution by secondary batteries. Mr. Gordon had gone very fully into the relative merits of the two systems, but he had been answered by several gentlemen who had joined in the discussion that evening, and the speaker was afraid he could not altogether agree to the conclusions Mr. Gordon had arrived at. Prof. Silvanus Thompson, as well as Mr. Mordey and Mr. Madgen, had called attention to his statement regarding the Faradaic theory. He wished to point out that the words "*and* exemplified by Ruhmkorff" should be "*as* exemplified by Ruhmkorff." M. Gaulard never dreamed of denying the Faradaic theory of induction, as such would have been absurd on the face of it; but he distinctly laid down the dictum that the Ruhmkorff coil more or less modified formed the basis upon which all previous experimenters had worked, and had consequently been utterly unsuccessful. Regarding Mr. Manville's mention of Jablochkoff, he denied that that electrician had ever conceived the idea of such a transformer system as now existed: he quite recollected the apparatus exhibited by M. Jablochkoff in Paris at the great International Electric Exposition of 1881, but that system then shown at work as a "transformer system" was no more—either theoretically or practically—like what Gaulard had discovered, than a Wimshurst machine was like a dynamo, and he did not think the subject worth discussion. Prof. Thompson had objected to his statement that when one transformer only was connected to a dynamo, it was "either in parallel or series," but he did not see how anyone would prove the contrary, in spite of the argument brought forward by the professor, since, like a "quarrel," it took more than *one* to make a parallel or series circuit. Seeing the hour was so late, he was unable to say more in answer to the remarks made by the numerous gentlemen who had joined in the discussion.

Royal Society.

"On the changes produced by magnetisation in the dimensions of rings and rods of iron and of some other metals." By SHELFORD BIDWELL, M.A., F.R.S.

In a paper communicated to the Royal Society in 1885,* the author has shown that the elongation which an iron rod undergoes when magnetised does not, as has been generally believed, remain unchanged at a maximum when the magnetising force exceeds that which is sufficient to produce so-called saturation. On the contrary, he finds that when the magnetising force is continually increased beyond this limit, the elongation becomes gradually less and less, until the rod, after first returning to its original length, ultimately becomes actually *shorter* than when in the unmagnetised condition.

The experiments described in that paper are, however, open to objection, on the following grounds:—(1) The field due to the magnetising solenoid was not quite uniform; (2) the effect of the ends of the rods was uncertain, and might have played some material part in the production of the phenomena in question; (3) all the rods used in the experiments retained a certain amount of permanent magnetism; (4) the experiments might with advantage have been carried further. The paper now offered to the society contains an account of some new experiments which were designed to meet the above objections.

Objections (1) and (2) were met by using rings instead of rods of iron, observations being made of the changes which occurred in their diameters under the influence of various magnetising forces obtained by passing currents of electricity through coils of wire encircling the rings. To remove the third objection the rings were demagnetised before every observation, by a modification of the method described by Prof. Ewing in the "*Phil. Trans.*," vol. 176, p. 537. And lastly, the battery employed was increased from seven Grove's cells to thirty.

After an explanation of the precautions taken to guard against the effects of current heating, an account is given of some experiments with three rings arranged in slightly different ways, and the results are compared with those of an experiment made under similar conditions with the straight rod. It was found that in their general character the phenomena of elongation and retraction were just the same in both cases, and were in close agreement with those of the former paper. The differences in mere details were not greater than would probably be found to occur in different specimens of iron of the same form.

Being satisfied that these curious effects of magnetism were practically independent of the form of the iron, and having regard to the fact that it was much easier to obtain intense fields with straight than with circular solenoids, the author thought it worth while to make some further experiments with straight rods. The metals used in addition to iron were cobalt, nickel, manganese-steel, and bismuth; and the highest magnetising force reached about 840 C.G.S. units, the maximum in the old experiments having been 290.

It was found that the retraction of the iron continued to increase with higher forces until it was finally as much as 45 ten-millionths of the length of the rod, when there were indications that a limit was being approached. The retraction of the nickel reached 113 ten-millionths, when it also was evidently not far from its limit.

The behaviour of the cobalt rod was exceedingly curious and interesting. No evidence of any change of length appeared until the magnetising force exceeded 30 or 40 units. Then the length of the rod began to diminish, and continued diminishing until the force was about 400, when the retraction amounted to 50 ten-millionths. But beyond this point the rod gradually became longer again, and the retraction with the highest force of 800 units was only three-fifths of its maximum amount. It was ascertained that the maximum retraction did not coincide with a maximum of magnetisation, as might have been suspected to be the case. It is suggested that iron and nickel might possibly behave in a similar manner under sufficiently high magnetising forces.†

Tables and curves are given showing the relation between magnetising force and changes of length in each metal.

Bismuth was found to be slightly elongated in strong fields, though no change could be detected with forces of less than about 500. The greatest elongation observed was about 1·5 ten-millionths of length.

Manganese-steel was almost unaffected. The elongation in a field of 850 was estimated to be about one fifty-millionth of the length.

Finally, it is shown that the mechanical stress produced in iron by magnetism does not account for more than one-fifth part of the observed magnetic retraction.

An appendix to the paper contains evidence of the high degree of accuracy obtainable by the method of observation employed. In the very great majority of the measurements of elongation and retraction, the probable error was less than one two-and-a-half-millionth part of an inch, or one hundred-thousandth of a millimetre; and the results of experiments made upon different days (the apparatus having been in the meantime dismantled), or with currents of ascending and of descending strength, were strikingly concordant. This degree of precision is attributed to the perfection of the optical arrangements, which rendered it possible to project the image of a wire with such sharpness, that after reflection from a mirror its position upon a scale 24 feet (732 cm.) distant could be read to a quarter of a scale division, each whole division being equal to $\frac{1}{40}$th inch (0·64 mm.). The magnifying power was such that a change of one two-and-a-half millionth part of an inch (or one hundred-thousandth of a millimetre) in the length of the rod under examination caused the image of the wire to move through about three-quarters of a scale division. More accurately, a scale division corresponds to 0·000018 mm.

The currents used were measured by one of Ayrton and Perry's commutator ammeters, and the accuracy with which the magnetising forces were estimated, though quite sufficient for the purpose of the experiments, does not claim to be very high.

Physical Society, February 25th, 1888.

Prof. REINOLD, F.R.S., President, in the Chair,

Mr. Hugh Frank Newall was elected a member of the Society.

The PRESIDENT read a letter received from the Council of the Royal Meteorological Society, referring to the forthcoming exhibition of apparatus used in observations of atmospheric electricity, and requesting the loan of such apparatus belonging to members of the Society.

* "*Roy. Soc. Proc.*," vol. 40, 1886 (No. 242, p. 109).

† It is also suggested that some specimens of cobalt and nickel might, like iron, begin with a small preliminary elongation, thus accounting for Prof. Barrett's observation that cobalt undergoes elongation when magnetised (*Nature*, Vol. 26, p. 585).

The following papers were read: "Note on the efficiency of incandescent lamps with direct and alternating currents," by Prof. W. E. AYRTON, F.R.S., and Prof. J. PERRY, F.R.S. This relates to the question whether the "efficiency" (candles per watt) is greater or less for alternating than for direct currents. Experiments made by Messrs. Shepherd and Wheatly, two of the students at the Central Institution (to whom the authors express their thanks for the valuable assistance rendered), show that no appreciable difference can be detected when the lamp is at the same candle-power. In performing the experiments three-way switches in connection with Gramme and Ferranti machines were arranged so that the current through the lamp could be quickly changed from direct to alternating or *vice versa*, adjustable resistances having been previously placed in the two circuits to give equal readings on a Cardew voltmeter placed as a shunt to the lamp. The currents were measured by a reflecting dynamometer wound with fine wire, in order to make the error due to unequal current density over the section negligible. The problem has also been investigated from theoretical considerations, but the results as yet deduced, would not lead the authors to anticipate the equal efficiency found experimentally. An interesting discussion followed, in which Mr. Swinburne, Prof. S. P. Thompson, Mr. Boys and the authors took part.

"On the temperature at which nickel begins suddenly to lose its magnetic properties," by Mr. HERBERT TOMLINSON, B.A. Different authorities give different values ranging from about 300° to 400° C. In investigating the subject the author found that the said temperature depends on the magnetising force used, *e.g.*, with magnetising forces of 5, 99, and 182 units the temperatures at which the permeability attained its maxima were 287° C., 248° C., and 242° C., γ, and those corresponding to permeability, σ, were 333°, 392°, and 412° respectively. From the above results it will be seen that for small magnetising forces the change of permeability from maximum to σ is much more sudden than for the greater forces. As in iron, the permeablity decreases as the magnetising force increases. An experiment was shown in which a nickel-plated brass wire was heated to dull redness whilst suspended between the poles of an electro-magnet and allowed to cool. When the critical temperature was attained the wire was suddenly attracted to one or other of the poles. In reply to Mr. Shelford Bidwell the author stated that the changes in permeability due to ordinary atmospheric changes of temperature were considerable when small magnetising forces were used.

"Experiments on electrolysis," by Mr. W. W. HALDANE GEE, B.Sc., Mr. H. HOLDEN, B.Sc., and Mr. C. H. LEES, B.Sc. Whilst studying some electrolytic polarisation phenomena with palladium electrodes in dilute sulphuric acid (pure) a dense liquid was seen *after reversing the current* to flow downwards in streaks from the anode. The paper is devoted to the investigation of the character of the liquid streaks, and the authors conclude that the streaks are of concentrated sulphuric acid formed by the union of the hydrogen (occluded by the electrode whilst serving as cathode) with the SO_4 liberated at the same electrode when the current is reversed. Similar streaks were found with phosphoric acid, &c.

In their next paper the authors hope to describe some experiments in which these and similar effects become of great importance in changing the resistances of electrolytes.

CORRESPONDENCE.

Insulation of Conductors for Internal Work.

It is rather difficult to place a practical value on Mr. Addenbrooke's contribution to your journal upon the insulation of conductors for indoor electric lighting. Were I disposed to adversely criticise the article in question I might suggest that of the statements therein made many are mere truisms, others are simply repetitions of much which has already appeared in the ELECTRICAL REVIEW; while the remainder are based upon assumptions unsupported by figures or other tangible evidence. Perhaps in this last respect Mr. Addenbrooke has been wise, lest, perchance, "sus sibi gladio hunc jaculo."

There are two points, however, among your contributor's remarks which stand out in conspicuous relief from the rest of the article. One is his advocacy of ozokerite, as being preferable to other materials for insulating wires, comparing it more particularly with India-rubber. But, unfortunately for this comparison, Mr. Addenbrooke has, on the one hand, selected a "first-class" ozokerite-covered wire, and, on the other, an "unsatisfactory" rubber-coated conductor. Now, a suspicious mind might detect some trace of nepotism in such a comparison, else why start on a basis so obviously unfair to India-rubber? The comparison referred chiefly to the question of cost; but it would appear to me, and I look for further information on this point, that in dealing with comparatively light conductors, such as I am given to understand are generally used on branch circuits in houses, the labour necessary for the manufacture will be a large proportion of the total cost, whatever may be the insulating material employed. And in addition to this, when the expenses of installation and fittings are taken into consideration, it will be found that the percentage difference on the total cost, whether a well insulated lead or one giving, let us say, only 100 ohms dielectric resistance, be employed.* Perhaps Mr. Addenbrooke could supply some data as to the comparative cost of ozokerite core, and, let us say, India-rubber.

I have hitherto been led to believe that ozokerite, or any "compound" ozokerite, is, owing to the defects inherent in all resinous bodies, much inferior to rubber in toughness, pliability, and enduring power, and that consequently the latter-named material affords a far superior mechanical protection. Another question of some importance presents itself. To what extent does ozokerite affect the cotton covering? It is well known that many of the so-called insulating compounds have a prejudicial effect upon fibrous materials, through chemical action. Mr. Addenbrooke does not inform us which particular "ozokerite compound" he refers to.

The other point which attracts attention is your correspondent's advocacy of so low an insulation as 100 ohms. He very justly remarks that fire insurance companies might stand aghast at such an idea, and I would add not fire insurance companies only. The strength of a chain must be gauged by its weakest link, and it seems to me that with a general insulation reduced to so low a figure there would be little or no protection at those weaker spots which are present, to a greater or less degree, in all insulating materials. The continued loss of so much current through the dielectric must result, with time, in a dangerous deterioration of the material. Why trouble about any insulation at all if the insulating covering is to be a sort of sieve? It is only fair to ask which covering would be most exposed to the early development of a fault, that which commences life with an insulation of several megohms, or the one which at its best only gives a dielectric resistance of 100 ohms? It must be remembered that faults in conductors do not always show immediately, and a defective place would require to assume almost the proportions of a short circuit before it could be discovered under the condition of such abnormally low insulation as suggested by Mr. Addenbrooke, who would really appear to rely on the doctrine of chances, and to have adopted as a motto the lines from Ovid's "Fasti":—

> Exitus in dubio est: audebimus ultima dixit,
> Viderit audentes forsne Deusne juvet.

I have read with great interest in the pages of the ELECTRICAL REVIEW certain correspondence with regard to the insulation and mechanical protection of conductors for electric lighting. Mr. Brooks champions his own particular mixture. Mr. T. O. Callender naturally resents any disparaging criticism of his bituminous compound, while "F. I. C. F. C. S." valiantly takes up the gauntlet in defence of the Berthoud-Borel cables. But neither in the contributions of these gentlemen, nor in the many other letters and articles on the subject which have appeared in this Journal, can I find any recommendation to so low an insulation as Mr. Addenbrooke favours. On the contrary, high insulation, accompanied by mechanical efficiency, seems to be the point aimed at.

Your correspondent seems to forget that the mechanical properties of the covering, which he lays so much stress on as opposed to dielectric resistance, are required not for the purpose of protecting the conductor from injury, but to save from damage the very insulation he apparently decries. He admits that there is a possibility of bare wires being short circuited, then insulated conductors are also liable to be crossed; he states that moisture is the great enemy which must be

* Our correspondent has evidently omitted something here.—EDS. ELEC. REV.

guarded against; he graphically describes the large quantity and high tension of current present in electric lighting circuits; surely these are all cogent reasons for paying some attention to the insulation of the conductors. It cannot be too strongly insisted upon that mechanical protection must be accompanied by good insulation. The two attributes go hand in hand, and cannot be separated.

Mr. Addenbrooke remarks that the faults which occur in *properly* wired houses are few and far between. Exactly so, and I would add that if we reduce the quality of the leads we shall have improperly wired houses, and bring more trouble upon ourselves than is ever likely to accrue through faults in switches, cut-outs, &c. One might aptly quote:

Eventu nerum stolidi didicere magistro.

Anne Insulator.

I have very little doubt you will receive communications from persons very much better qualified to criticise Mr. Addenbrooke's articles than I am, but in case you do not, I feel I must write a few lines to show that every reader of the ELECTRICAL REVIEW does not concur in everything Mr. Addenbrooke says. With regard to a paragraph in a paper of his on page 62 of the present volume, about jointing electric light leads, may I say a few words?

Mr. Addenbrooke seems to find a great difficulty in soldering with resin. I may say that no man ought to be considered able to solder at all who cannot solder a joint perfectly with resin. It is just as easy to solder with resin as with "spirits" if the wire is properly cleaned, &c.; and considering the immense harm "spirits" are apt to cause, it should not be used *under any consideration whatever*. Has Mr. Addenbrooke found one man in twenty he can trust to thoroughly clean a joint after it has been soldered with "spirits"? I can say from practical experience it is quite easy to solder joints made in 19/14 wire with resin, but I should hardly make a joint in the way Mr. Addenbrooke proposes. His would be a very poor joint mechanically, and it is well known that the failure in installation is caused not by electrical defects but mechanical defects. The only really possible joint is a spliced joint. The ends are bared for about five inches, the outside layers of both ends are lifted back, the cores are cut off about two inches long, they are then butted up against each other. The wires in the outside layers are placed alternately and are then twisted neatly round the opposite core, *i.e.*, the wires of A are laid round B and *vice versâ*; if this is well done it makes a joint which, if not soldered, would not pull out, but when soldered makes an absolutely perfect joint. With regard to fastening the conductors to switchboards: in the first case which Mr. Addenbrooke mentions, where the conductor passes through a hole in a brass terminal and a screw is driven down at right angles to the conductor, a very good plan is just to solder the strands at the end together and then the clamp screw easily holds them; though there should be some kind of lock nut to the clamp screw so that it does not work loose, especially on board ship, &c. In a large number of the switches made now, there is a brass tube into which to solder the wire. With regard to Mr. Addenbrooke's paper on the *insulation* of conductors for internal work. It seems almost as if Mr. Addenbrooke's experience of electric lighting had been taken from a test room or some School for Electrical Engineering, where everyone knows more or less about the work, and no one is likely to lay a piece of iron across the wires "just to see what it does."

The only way to put up an installation is to reduce all chance of a mishap to a minimum, and this is only done by putting in the best possible work. Supposing conductors with the covering Mr. Addenbrooke proposes were used; after they have been pulled into place up two, three and four stories, round sharp corners, &c., by a gang of men, what chance is there that the insulation will be perfect? It is very easy to lay a cable down on paper, but in practice it is very different. For a cable has to be pulled through here, round here, up there, back here, along there, &c. And if Mr. Addenbrooke has ever tried to pull, say 100 ampère copper some distance round corners, he will find it does not come very easily. Say, some of the covering is pulled off both cables, it is nearly certain to be in some awkward corner where a man could not get at it to hold it round; the cables come together, there is a short circuit, the lights go out, the insulation fails at the very worst part to get at. No; if there is one place where the insulation ought to be good it is in the cables which are for the most part hidden, after an installation has been put up and is being looked after by a man who is more or less of an engineer. Suppose, on the one hand, there is a short circuit in the cables, what a time it will take to put right; suppose, on the other hand, something goes wrong with a switch, it is easily seen and remedied. Improve the switches, &c., by all means, but not at the expense of the cables. What cable stands hard work better than the India rubber covered cable with an outer covering of woven hemp which Mr. Addenbrooke so much despises? It is waterproof it is flexible, it won't tear off, the cable can be heated to a great extent without affecting the covering, it is easily cut off to make joints. The cable can be handled by the man without any fear of its being seriously injured. Will Mr. Addenbrooke say what would be the effect if his conductor, with only a braided covering, were pulled along against the corner of an iron girder, or even a corner of a brick wall or a nail; all these things may happen. There are several places where lamps have been "got to work," but there are not many places where the installations have been put up from beginning to end with a view to last. Apologising for having taken up so much of your valuable space.

J. A. Jeckyll.

February 21st, 1888.

"Electrostatic Attraction in Liquids."

At the end of the account given in your issue of March 2nd of the note communicated by M. Gouy to the Académie des Sciences on the excess of attraction found to exist between two conductors maintained at a given potential difference, when immersed in distilled water, over the attraction when the conductors are in the air, you say: "The exact cause of the phenomenon seems doubtful." May I, therefore, refer you to the enclosed pamphlet,* published by Prof. Perry and myself some eleven years ago, showing how the attraction between two definite quantities of electricity, or between two conductors with a fixed potential difference (P.D.) between them at a definite distance apart, varied with the specific inductive capacity of the dielectric separating them. This pamphlet followed that containing the account of our experiments on the specific inductive capacity of gases, and in it we showed that the force between two quantities of electricity at a given distance apart in any medium of specific inductive capacity, i, was equal to the reciprocal of i into the force between the same quantities of electricity at the same distance apart in air at the normal pressure and temperature, the force, therefore, *increases* if the bodies, with fixed charges, be put in a vacuum or in hydrogen gas, and diminishes if put in a dense gas, like sulphurous acid, or in a liquid.

If, however, instead of the charges of electricity and the distance apart of the bodies being fixed, the P.D. between the conductors and their distance apart be fixed, as was the case in M. Gouy's experiments, it follows from the calculations given in our paper that the force will be *increased* in the ratio of unity to the specific inductive capacity. Or more exactly, the force

* "On certain modifications that must be introduced in the fundamental notions of the mathematical theory of electricity."

in grains per square inch between two parallel plane conductors d inches apart in a dielectric of specific inductive capacity, i, when the conductors have a P.D. of V volts between them is

$$i\,\frac{6{\cdot}955\ \mathrm{V}^2}{10^9\ d^2}$$

Now if the dielectric be a semi-conducting liquid, then, as pointed out by us in our papper "On the Viscosity of Dielectrics," *Proc. Roy. Soc.* 186, 1878, its specific inductive capacity will increase as its specific resistance diminishes, hence distilled water of a certain degree of purity will have a value of i, equal to 100, and the force between two conductors, with a fixed P.D. between them at a fixed distance apart, will be (as it was found to be by M. Gouy) 100 times as large when the conductors are in the water as when they are in air.

If, on the other hand, the liquid have a much higher specific resistance, be paraffin oil, for example, i will be about 2, hence the deflection of the needle of a quadrant electrometer at a fixed potential when the quadrants have a fixed P.D. between them will be doubled, that is, the sensibility of the electrometer will be doubled if the space between the quadrants below and at the sides be closed up liquid tight with some insulating substance like ebonite, and the interior of the quadrants be filled with paraffin oil. With an hydrous paraffin oil, the insulation would probably be high enough for the electrometer to be used for testing the E.M.Fs. of cells, &c., the damping would be good, and the sensibility doubled. This suggested mode of increasing the sensibility of a quadrant electrometer we put forward several years ago, but, as far as we are aware, the device has not yet been tried.

W. E. Ayrton.

Contact Piece of Metre Bridge.*

The contact piece of a metre bridge as usually made is apt to give some trouble to the manipulator if not carefully used. In order that its action should be more sure and easy, the following method has been devised by me for our laboratory :—A, fig. 1, is a cross-section of the bridge, and fig. 2 a plan of a portion, including the contact piece. C is the metre scale, E copper conductor, D B the contact piece; it consists of a heavy metal cylinder having hemispherical ends, and it may be slid along the groove, F, either in contact with the wire, G, or deflected through an angle a, so as to break the galvanometer circuit. Connection with the key is made either by attaching a wire to a binding screw fixed to the contact piece, or by facing the groove with a metallic side which forms part of the galvanometer circuit. Since the groove is parallel to the scale, all error from different positions of the contact piece is avoided. When several wires are used instead of one (a method shown in Prof. Ayrton's book on "Practical Electricity," p. 414), as many little plungers as there are wires may be added to the arm, so that any wire may be used at pleasure.

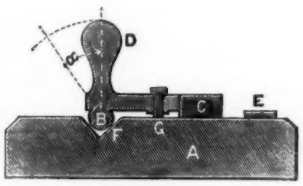


FIG. 1.

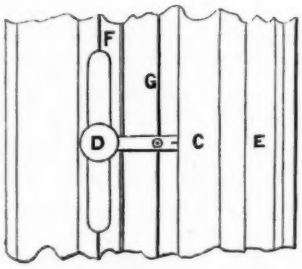


FIG. 2.

Frederick J. Smith.

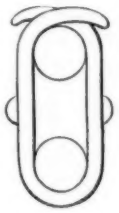
Millard Engineering Laboratory,
Trinity College, Oxford.

* Abstract of a paper read before the Ashmolean Society, Oxford, February 27th, 1888.

Renewal of Aerial Line Wires.

The patented device illustrated in your issue of the 2nd inst. does not seem to me, from practical experience, to be anything very special, for the following reasons, viz. :—

1. Because it was the first device I thought of and abandoned.
2. Because the thumbscrew is liable to get slack, or be neglected, and thereby allow the so-called runner to be drawn off the end of the arm, on acute curves especially.
3. Because by drawing the wire over the runner it is apt to come in contact with the bottom wires, owing to the swinging motion in pulling it, unless the runner extends several feet out from the end of the arm.
4. Because the wire is apt to get out of the runner where there is upward pull, unless the prongs were shaped thus :—



I may mention that 76 miles of wire have been renewed by the employment of the lever illustrated in the REVIEW of the 24th inst. without any hitch or inconvenience, and that I could not wish for a better or more practical device. As to the "scouring" and "skinning" of the wire when drawn over rough ground, this I consider insignificant. The wire should not drag along the ground. The coil of wire should be carried on a drum and run out in a similar manner to laying a submarine cable, and in most cases the wire, after leaving the drum, rests on grass.

Arthur E. Gilbert.

March 3rd, 1888.

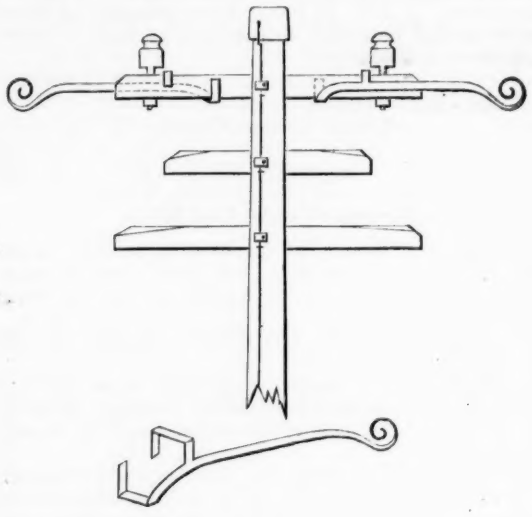
In your issues of February 24th and March 2nd several pieces of apparatus for use in renewals of telegraph lines are illustrated, one of which is said to be patented.

Permit me to say that a similar tool has been in use on the North-Eastern Railway for the last six or seven years, and has been found to be of great use in keeping off faults.

None of your correspondents note the fact that by means of this tool a saddle wire may be renewed without having to thread the new wire between the old ones —that is, that it may be run outside in exactly the same way as any of the wires on the arms. A little extra care in manipulation enables this to be done.

I do not think the tool in use on the North-Eastern Railway has been improved upon in any of the devices illustrated. Some of them scarcely appear to be able to withstand the lateral pull of a wire being erected upon

the inside of a heavy curve; since the outer clip is outside the insulator bolt there does not appear to be any provision made for preventing the tool from being pulled off the arm in the event of its being used in such a position.



This tool, as will be readily seen, is applicable to either end of the arm. It is so constructed as to allow both the upper and under supports to lie upon a 24-inch arm between the insulator bolt and the pole. The insulator bolt prevents it from being pulled off the arm by a lateral pull of the wire. The material is iron of a square section. Altogether it has during the time mentioned been a most useful tool, as it not only keeps the line clear of faults, but expedites the work when the men become accustomed to its use, and it also prevents the shedding of much valuable ink.

From the description of the method of using the American invention one would think that faults during renewals would there be the rule, not the exception.

(PI)².

March 3rd, 1888.

Re Ships' Compasses.

In answer to Mr. Malan who made an enquiry on the above subject in the REVIEW for February 24th, I might inform him that the "deviation" of the compass under the circumstances he mentions is only what might be expected, and that its correction is a very simple matter. The deviation is caused by the sub-permanent magnetism of the iron composing the bridge, and its name (+ or −) depends upon the "magnetic azimuth" that the bridge had whilst in course of construction. In fact, the bridge is nothing but one huge magnet, and the deviation can only be corrected by introducing *equal* and *opposite* magnetic forces; and inasmuch as a mass of soft iron placed anywhere near the bridge has a temporary magnetic character given to it depending upon its *induced* magnetism, it is seen at once that it will not lessen the deviation. I should advise Mr. Malan to consult Sir F. Evans's manual of the deviation of the compass, and if he wishes the compass in question to be corrected and the whole thing explained on a scientific and practical basis, I can not do better than recommend him to apply to the perhaps most scientific compass-adjusters that I know of, viz., Messrs. F. Wiggins and Sons, of 10, King Street, Tower Hill, E.C., or if he would care to send me the necessary data I should be glad to assist him.

Geo. Herbert Little, *Electrical Engineer, Late Chief Officer cable ss. Buccaneer.*

March 3rd, 1888.

The Crompton-Swinburne Dynamo.

Mr. Brown complains that I did not prevent the insertion of something supposed to be new that is, in reality, quite old. If he will read the specification he will find:—"Since filing our application for provisional protection our notice has been called to the previous publication of a description of a dynamo with the armature wire wound through holes near the periphery, Though this arrangement was probably made with the view of reducing the air space, no attempt was made at reducing the size of the magnets, or the power spent in them by this means. The magnets were apparently designed with the view of surrounding the field magnet coils with iron as completely as possible, with the idea that by such an arrangement each ampère turn would somehow have greater magnetising force. This is a common fallacy among dynamo makers."

The previous knowledge of the type of machine with internal magnets, now used by Siemens, is mentioned also.

The article on the invention of which Mr. Brown complains was, as you will remember, not written by me, and I am not responsible for it. All the same, it is an accurate description.

As to output and weight and "air resistance," I am afraid we must agree to differ. I do not follow Mr. Brown's arguments, but may say that we went very carefully into the subject, and if we had not found machines made according to our invention a great advance on those already known, we would not have gone on with the matter.

Jas. Swinburne.

Magnetic Resistance.

The magnetic circuit is founded on the analogy of the electric one, in which the total current equals the E.M.F. divided by the total resistance. Surely, then, it would be best to take the flux as the total magnetic induction, or

$$\phi = \frac{\text{magneto-motive force}}{\text{total magnetic resistance.}}$$

If we consider the case of an iron ring completely wound over with wire, so that the magneto-motive force is uniformly distributed, there will be no leakage. Now in an endless solenoid, the magnetising force $= \frac{4\pi n c}{l}$; where n is the number of turns, c the current in C.G.S. units, and l the mean circumference, and the magnetic induction or $B = \mu \frac{4\pi n c}{l}$

If A is the cross section of the iron core

$$\phi = A B = A \mu \frac{4\pi n c}{l} = \frac{n c}{\frac{\mu}{4\pi} \cdot \frac{l}{A}}$$

Here $n c$ represents the magneto-motive force; it is, however, more useful in practical work to express the current in ampères, so that we may write

$$\psi = \frac{\text{ampère turns}}{\frac{10\mu}{4\pi} \cdot \frac{l}{A}}$$

The magneto-motive force is now the number of ampère turns, and $\frac{10\mu}{4\pi}$ represents the specific magnetic resistance per cubic centimètre of the material forming the magnetic circuit.

E. C. Rimington.

Snowstorms.

I have read with pleasure the letter by "Celt" in your issue of the 2nd inst., and merely desire to say that I intend ere long writing you on a new system of survey and construction for railway telegraphs.

Arthur E. Gilbert.

March 3rd, 1888.